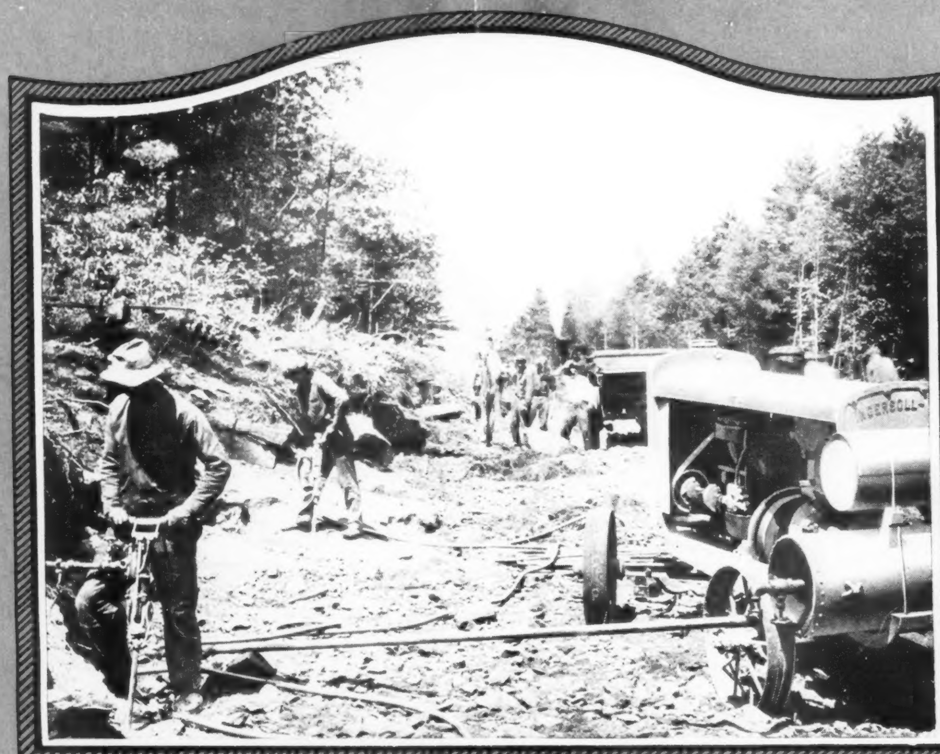
Compressed Air Magazine

Vol. XXXI, No. IX London New York Paris 35 Cents a Copy

SEPTEMBER, 1926

CIRCULATION THIS ISSUE
27,754 COPIES



MODERN EQUIPMENT HELPING THE STATE OF NEW YORK TO BUILD A MOTOR HIGHWAY OVER TONGUE MOUNTAIN ON LAKE GEORGE

Spectacular Salvage of Sunken Submarine
R. G. Skerrett

Gilboa Dam Now Finished
S. G. Roberts

How America Safeguards the Navigator
F. A. Collins

Oil Engine Effects Economies
C. K. Wildman

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)

CONTENTS OF THIS ISSUE

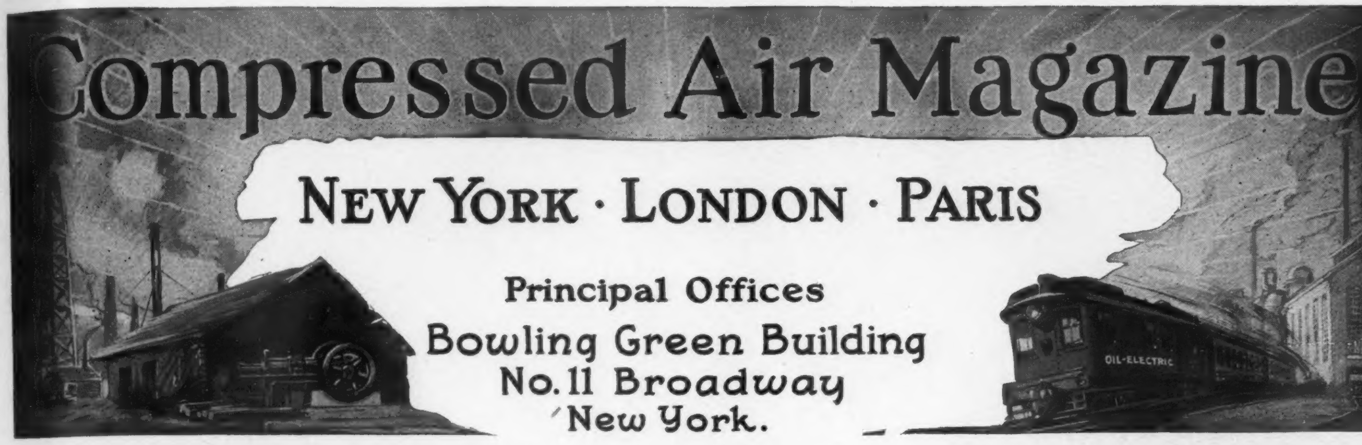
Vol. XXXI, No. IX, September, 1926

NOTE—For subscription terms see first Editorial page

Articles

Advertisements

As a matter of reciprocal business courtesy help trace results



VOL. XXXI, NO. IX

SEPTEMBER, 1926

Gilboa Dam Now Finished

This Big Dam Will Be the Means of Adding Daily 250,000,000 Gallons to the Water Supply of New York City

By S. G. ROBERTS

GILBOA, in the days when Saul and his sons fought the Philistines and died, meant "bubbling fountain." Today, the name of Gilboa brings instantly to the minds of the dwellers in New York City a great dam that now makes it possible to impound the waters of Schoharie Creek within a reservoir capable of holding 20,000,000,000 gallons of water so that the swelling numbers of the Metropolis shall have an abundance of this essential in the years to come.

The completion of Gilboa Dam brings to a climax the Schoharie development of the Catskill Water Supply System—a section of a great work which, in its entirety, has called for an expenditure of substantially $182,000,000. Gilboa Dam, with certain appurtenant structures, involved, up to the close of 1925, an outlay of $7,799,910. Such is the price paid to insure a plenty of water to the citizens of America's largest city and to those hundreds of thousands of people that daily enter and leave the gates of that city.

Gilboa Dam lies, by air line, 120 miles to the north and west of the City Hall; and to make the waters of Schoharie Creek available it has been necessary to reverse the direction of the flow of that stream and to lead the diverted waters into a tunnel, 18 miles long, that pierces the rocky backbone of the Shandaken range. In this way, the Schoharie adds its abundance to that of Esopus Creek, which empties into the great Ashokan Reservoir—also situated in the heart of the Catskill Mountains.

For more than a year, the Schoharie has been sending a part of its waters through the Shandaken Tunnel; and this diversion has been effected by a low, temporary dam built for the purpose at a point upstream above the great and permanent dam that has been nearing completion the while. From now on, however, Gilboa Dam will perform the dual function of sending the waters of Schoharie Creek southward and eastward into the Shandaken Tunnel and of impounding a vast measure of water within the reservoir formed by the flanking hills and by the man-made barrier which closes the normal outlet of the stream at that point of the valley where the Village of Gilboa used to stand.

THE completion of Gilboa Dam provides a diversion and impounding reservoir within which can be stored, during seasons of abundant rainfall, a matter of 20,000,000,000 gallons of water for the people dwelling in New York City, nearly 150 miles away.

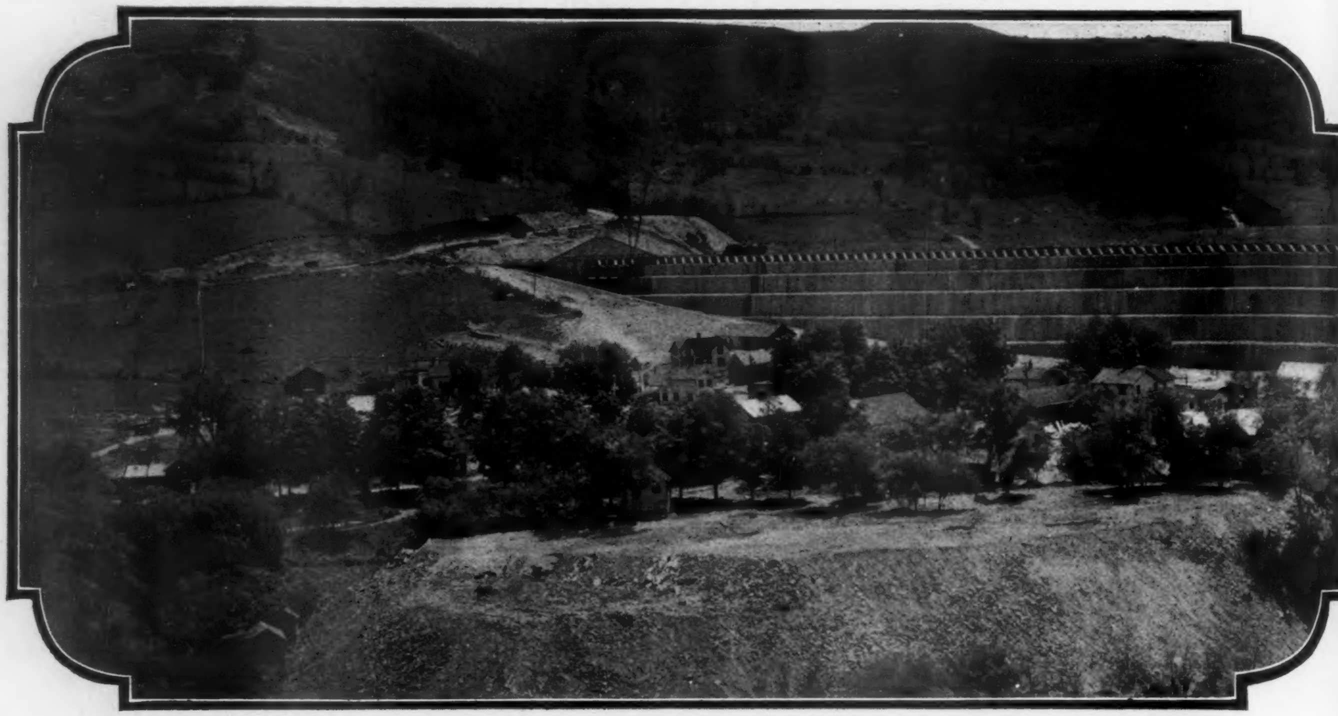
This engineering task has involved the excavating of nearly 400,000 cubic yards of earth at the dam site; the excavating of 157,000 cubic yards of rock; the refilling and embanking of 880,000 cubic yards of material; the placing of 483,000 cubic yards of masonry; and the utilizing of more than 500,000 barrels of Portland cement. It should not, therefore, cause wonderment that this immense engineering project has entailed an outlay of substantially $8,000,000.

The finishing of Gilboa Dam and certain appurtenant work brings to a present climax efforts to draw water from the heart of the Catskill Mountains and to deliver this wholesome flood to the 6,000,000 citizens of the Metropolis.

The contract for Gilboa Dam was awarded the Hugh Nawn Contracting Company in June of 1919—the estimated cost at that time being placed at $6,819,910. This figure has since then been increased, as indicated a few paragraphs back. Gilboa Dam is an engineering undertaking of the first magnitude, and is made up of two prime parts: an overfall masonry section, 1,324 feet long, that rises to a maximum height of 182 feet above the bottom of the cut-off, and an earth section, approximately 1,000 feet long, that is tied to the masonry section of the dam by a core-wall substantially 700 feet long. The top of the earth section of the dam is 20 feet higher than that of the masonry crest over which the flood waters of the Schoharie will pour during freshet periods. Before entering into the details of the dam structure, it might be well to touch upon the physical conditions of the neighboring country and upon the site chosen for the building of the dam.

The watershed tributary to the Schoharie Reservoir has an area of 314 square miles; and, because of the steep and rocky character of the surrounding hills, fully 69 per cent. of the rainfall becomes stream flow. In other words, the Schoharie can be depended upon to provide daily an average of 250,000,000 gallons of water wherewith to help fill the cup of Greater New York. The streams that feed into Schoharie Creek have their sources at elevations of more than 2,000 feet above the sea; and during the seasons of heavy rainfall the run-off is what is termed "flashy"—that is, the waters rush precipitately into the Schoharie. Therefore, a type of dam was chosen that would be able to provide an ample and yet a controlled escape for excess water after the reservoir was filled. This explains why the dam is of the overfall type.

As shown by a number of the accompanying photographs, the overfall section of the dam is of cyclopean masonry consisting of large blocks of stone embedded in concrete—the upstream face being finished with natural stone and the downstream face being composed of a series of



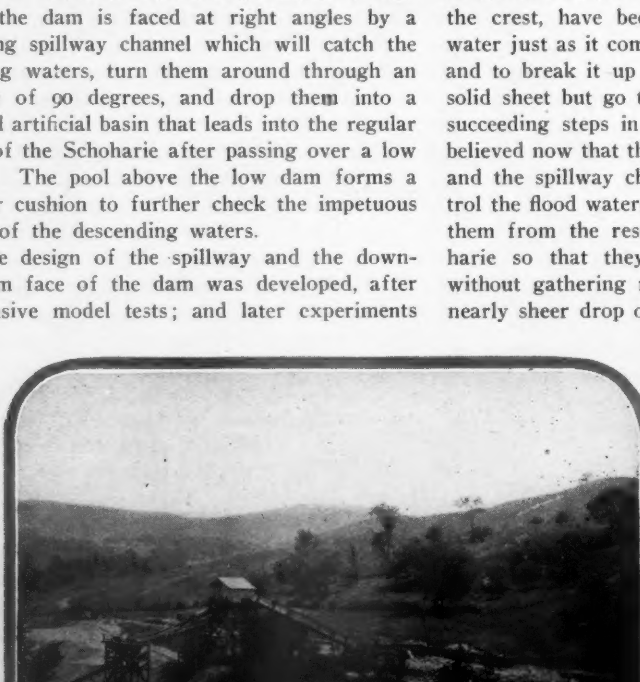
Gilboa Dam when nearing completion, with the baffle plates in position immediately below the crest.

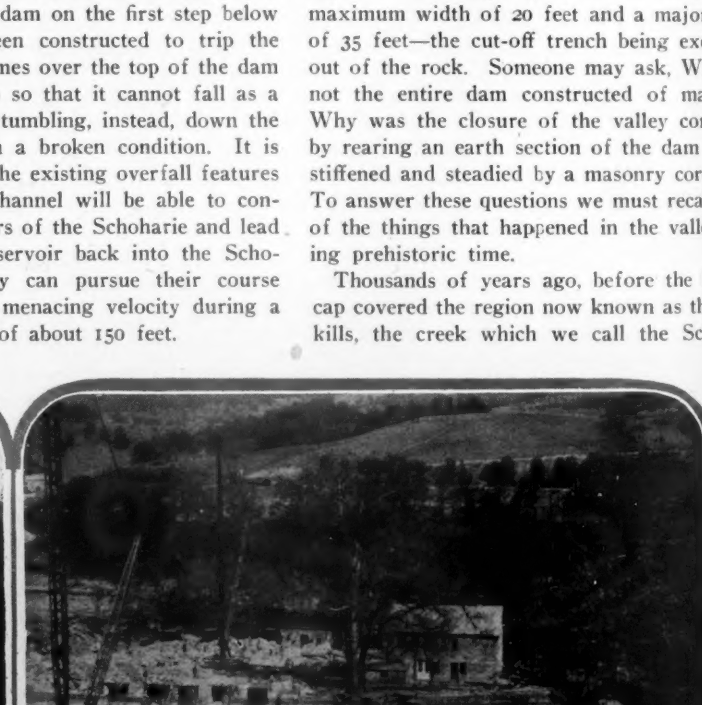
large steps or altars, faced with ashlar or cut stone, ranging from 7 to 20 feet in tread and rise. The purpose in forming the downstream face in the manner described is to break up the momentum of the overflowing waters during flood periods and to rob them of their directive force or violence. As an added means to this end the dam is faced at right angles by a sloping spillway channel which will catch the falling waters, turn them around through an angle of 90 degrees, and drop them into a paved artificial basin that leads into the regular bed of the Schoharie after passing over a low dam. The pool above the low dam forms a water cushion to further check the impetuous flow of the descending waters.

The design of the spillway and the downstream face of the dam was developed, after extensive model tests; and later experiments and additional run-off data, obtained during freshet periods, convinced the experts of the Board of Water Supply that still other means would have to be devised to check the directional force of the overflowing waters. Therefore, a series of concrete baffles, set diagonally to the face of the dam on the first step below the crest, have been constructed to trip the water just as it comes over the top of the dam and to break it up so that it cannot fall as a solid sheet but go tumbling, instead, down the succeeding steps in a broken condition. It is believed now that the existing overfall features and the spillway channel will be able to control the flood waters of the Schoharie and lead them from the reservoir back into the Schoharie so that they can pursue their course without gathering menacing velocity during a nearly sheer drop of about 150 feet.

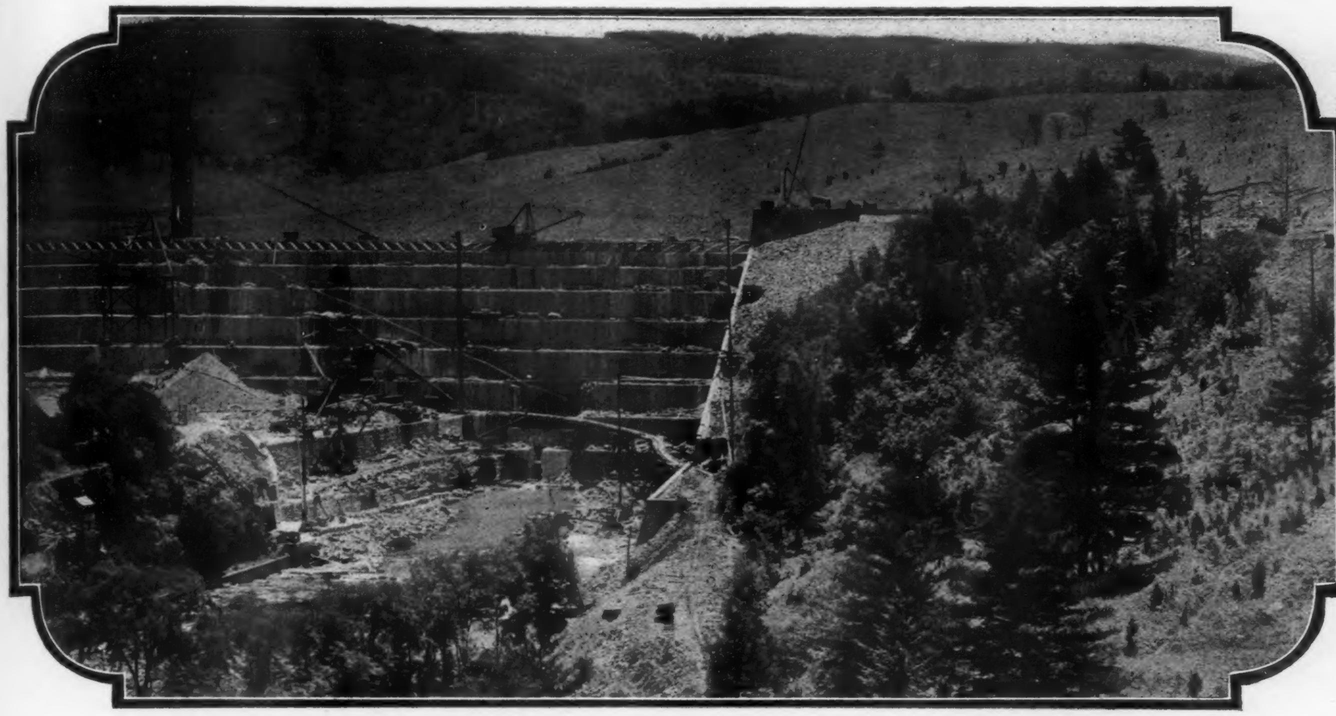
At its base, the masonry section of the dam has a width of 160 feet, while at the crest the dam is 15 feet wide. This masonry part of the dam rests upon the bedrock that underlies the surface of the valley; and the masonry is keyed to the ledge by a cut-off that has a maximum width of 20 feet and a major depth of 35 feet—the cut-off trench being excavated out of the rock. Someone may ask, Why was not the entire dam constructed of masonry? Why was the closure of the valley completed by rearing an earth section of the dam that is stiffened and steadied by a masonry core-wall? To answer these questions we must recall some of the things that happened in the valley during prehistoric time.

Thousands of years ago, before the last ice cap covered the region now known as the Catskills, the creek which we call the Schoharie





Left—Screening and sand-washing plant at work a short distance upstream from the dam, whence the material was easily delivered to the centrally located concrete mixers.
Right—Cutting yard at the Riverside Quarry where the ashlar was turned out for facing the masonry section of the dam.

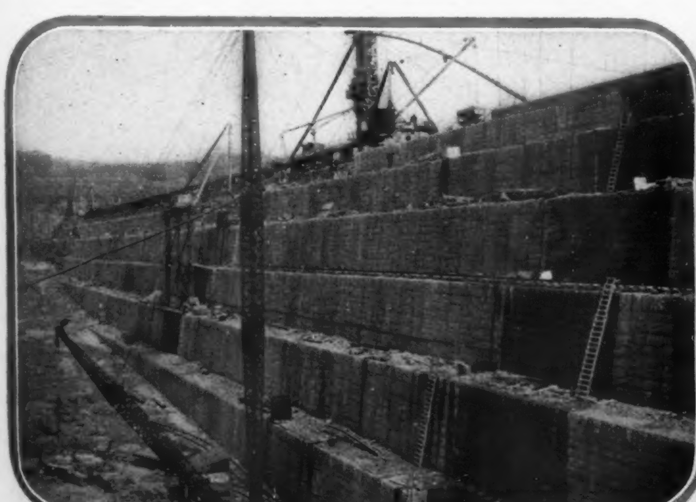


The valley on the farther side of the dam forms a reservoir that will hold 20,000,000,000 gallons of water.

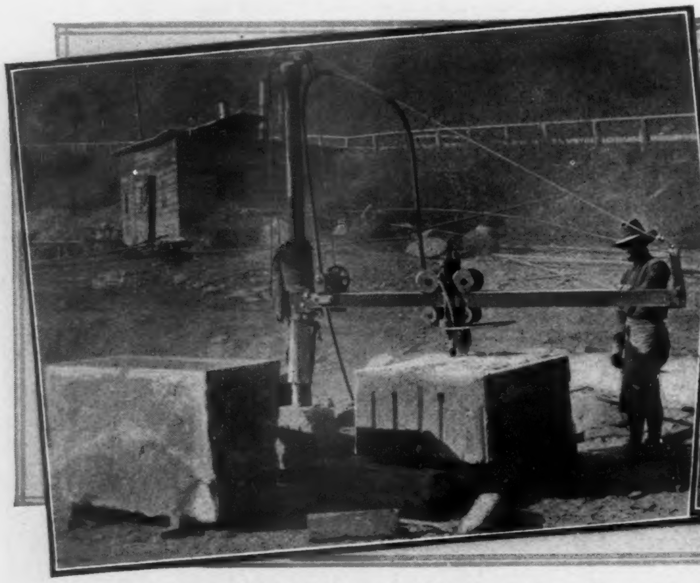
threaded its way through a narrow rocky gorge, the bottom of which underlies the present stream bed at a depth of fully 100 feet. When the retiring glaciers ground their way down the valley, their erosive action gradually built up a deep accumulation of sand, gravel, clay, and boulders—technically known as glacial drift, and incidentally raised the bed of the stream. This glacial drift lacks the stability necessary for the support of a massive and towering masonry structure. Exploratory borings revealed the situation and disclosed that the masonry dam would have to end at the eastern side of the prehistoric gorge because it would be impracticable to carry the masonry work down to the final rock below the existing stream bed. Therefore, in order effectually to close the gap between the western end of the masonry dam and the slope of the valley beyond, the engineers of the Board of Water Supply of the City of New York decided to rear a masonry core-wall that would complete the union with the neighboring hillside, and to flank this wall both upstream and downstream with earthen embankments which, in themselves, would have sufficient weight and stability to hold back the waters of Schoharie Creek when the reservoir should be filled.

The core-wall of this dike has a height, in some places, of more than 150 feet above the normal surface of the stream; and this wall is curved so as to present its convex side to the reservoir area. The core-wall rises from a trench that was dug at one point to a depth of 80 feet below the original surface of the adjacent ground. The core-wall serves principally as a stop or curtain to intercept any ground water which might work through the dike and undermine that section of the dam. Strictly speaking, the core-wall does not add materially to the strength of the earthen section. This fact should be kept in mind by such of our readers that may recall that a slight fracture developed last year where the core-wall joins the masonry dam.

That fracture was probably induced by the unbalanced masses of the opposing embankments on the upstream and the downstream sides of the wall. When the opposing embankments were balanced by an equal distribution of earth on each side of the core-wall no further movement occurred to widen the crevice between the core-wall and the masonry dam. While the foundation of the core-wall rests mainly on the glacial drift forming the valley bed, still that drift has been stiffened or consolidated by forcing grouting into the contiguous and underlying ground. To this end, pipe casings were driven down through the drift to bedrock. With the piping serving



Left—The steps which form the downstream or overfall face of the dam.
Right—Stream-control conduit through the dam, the sealing of which started the impounding of the waters of Schoharie Creek.



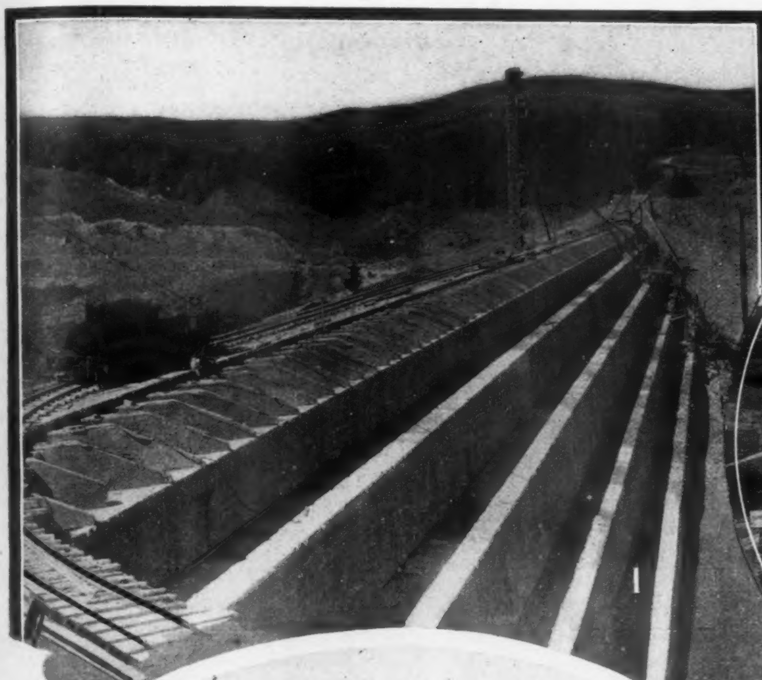
Left—An air-operated surfacing machine at work in the quarry cutting yard.
Right—One of the electric-air channelers employed in excavating the cut-off trench for the masonry section of the dam.

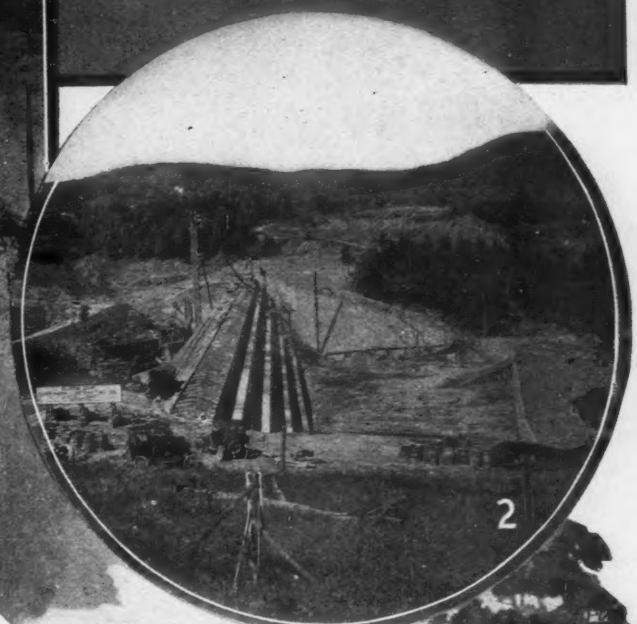
as guides for well drills, drilling was carried down through every other pipe to a depth of 20 feet into sound rock. With the drilling completed and the casings in position, grouting was forced into the pipes under air pressure, and the process generally continued until the drift refused to receive more of the binding mixture.

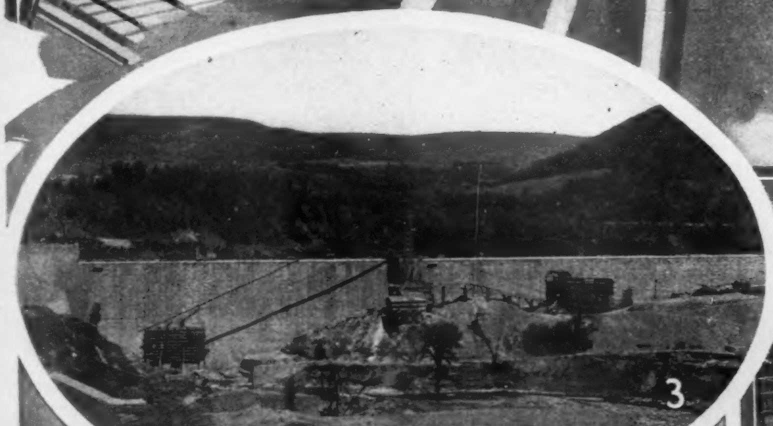
After each hole was grouted to refusal, the casing was raised 2 feet by hammer blows and the grouting resumed. As the work progressed and the space about the casings became impregnated with grout it was found impossible to raise the casings. Accordingly, the casings were ruptured with light charges of dynamite so that further grouting could be done. These ruptures were made at vertical intervals of 5 feet, and were followed in each instance by grouting to refusal. Thus the handicapping conditions of Nature's making were overcome, and the core-wall was given a satisfactory bed on which to rest in serving as a waterproof barrier in the center of the dike. Some of these grouted holes were drilled to a depth of 120 feet below the foundation of the core-wall.

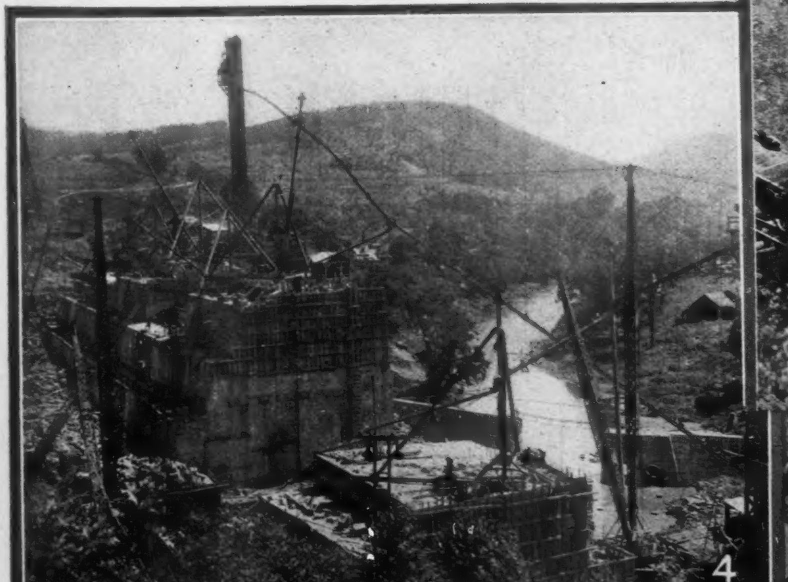
Material for the earth dike has been obtained mainly from a borrow-pit located on a hill above the western end of the dike and about 1,500 feet away. All told, more than 500,000 cubic yards of earth have been moved, distributed, and compacted by power rollers in forming the slopes of the dike. The earth was delivered to the dike by a narrow-gage line that was extended along the exposed crest of the core-wall. The earth was conveyed in 4-yard dump cars, and then loaded by steam

Top, left—L. E. Dennis, who has supervised the completion of the dam. Right—Placing 24-inch paving on slope of upstream face of dike.
Bottom, left—Tractor steam shovel delivering earth to teams for distribution on the dike. Right—Earth on the dike was compacted by 10-ton steam rollers.









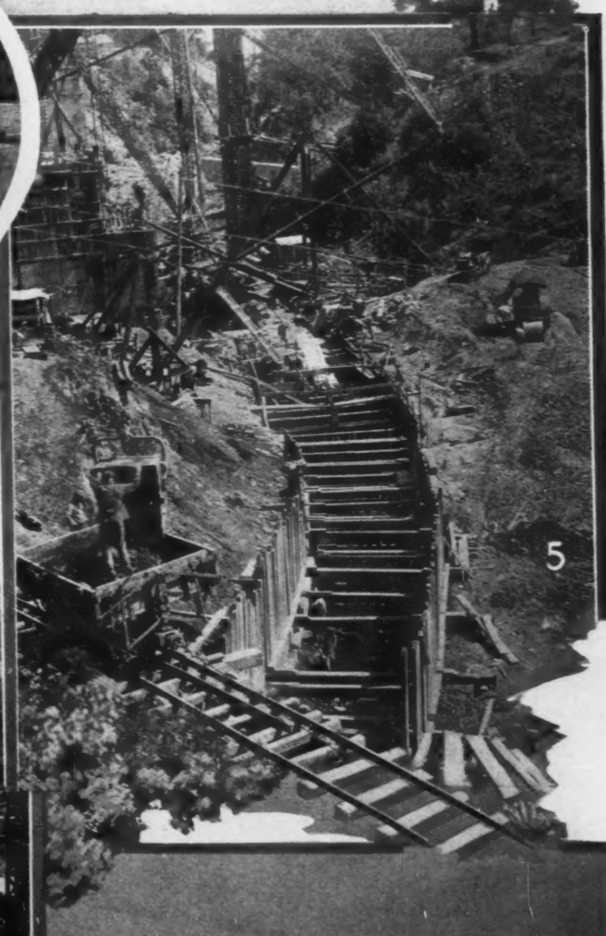
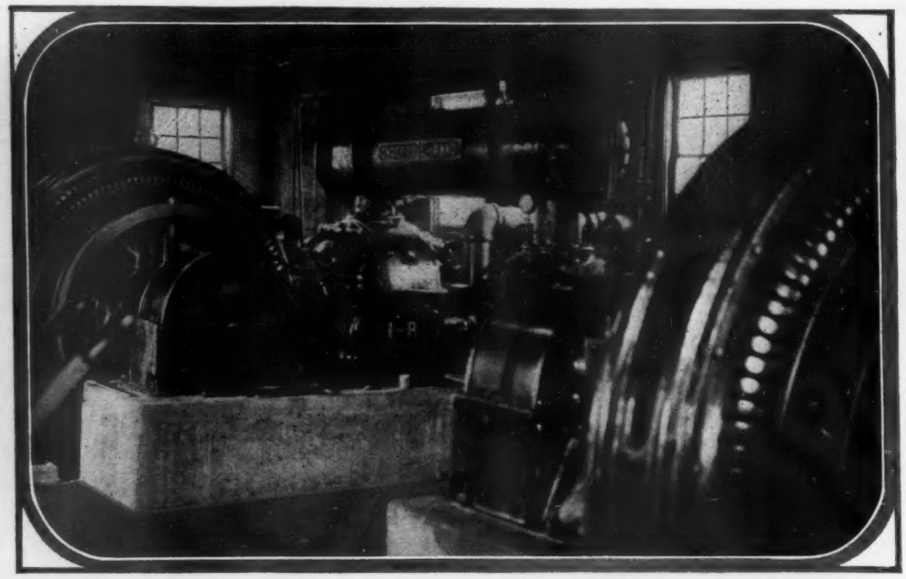


Fig. 1—Downstream face of the dam with reinforced-concrete baffles in place just below the crest line.
Fig. 2—Looking westward down the slope of the spillway channel by which the overflowing water will be dropped into a cushioning pool before resuming its normal course northward.
Fig. 3—Upstream face of the dam. Picture taken when stream-control outlet, at the left, was partly closed.
Fig. 4—Dam as it appeared during one of the early stages of construction.
Fig. 5—Trench excavated for use in connection with stream control during a period of the dam's erection.



One of the two "PRE-2" compressors that have furnished 2,600 cubic feet of air per minute for many purposes.

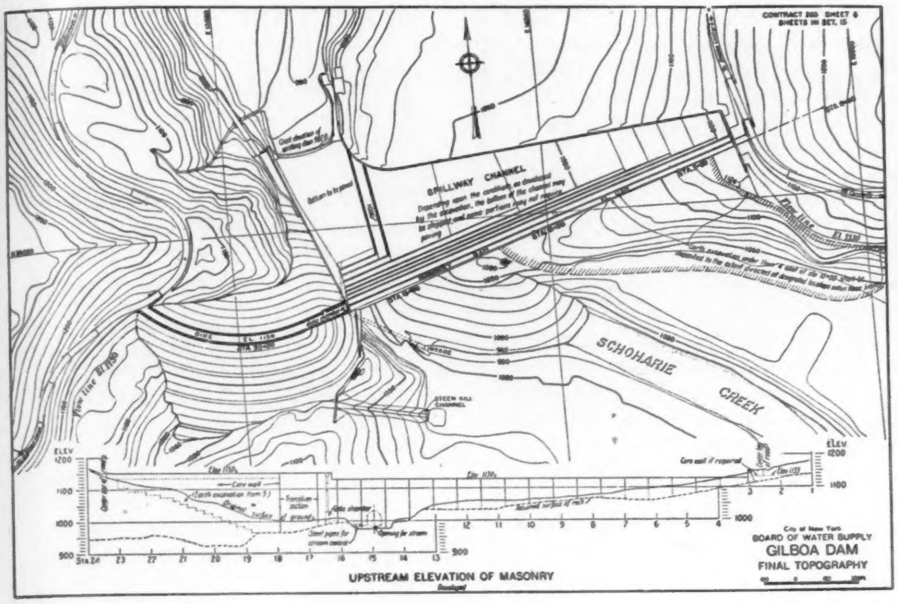
shovels into mule-drawn carts which distributed the material to the points desired.

In preparing the foundation for the masonry overfall section of the dam it was necessary for the contractor to clear away much fractured rock before getting down to the more nearly solid ledge, in which was to be excavated a cut-off trench by which the dam is keyed to the bedrock. In excavating the cut-off trench, electric-air channelers, reciprocating air drills, and "Jackhamers" were variously employed. Where channelers were used, the rock between the channels was broken free by close drilling and by the use of plugs and feathers. In excavating the downstream face of the trench, especially, close drilling was resorted to—a double staggered line of holes being drilled with "Jackhamers," and the bridges afterwards split by the plug-and-feather method. The nature of the rock encountered determined the use of either the drills or the channelers. Substantially 150,000 cubic yards of rock were excavated in preparing the foundation for the dam and in clearing the spillway channel. Compressed air for operations at the dam site was supplied by two electrically driven, direct-connected compressors, of the "PRE-2" Type, located about three quarters of a mile away—the air being delivered to the work through a 4-inch line.

Even after reaching what the engineers describe as "final rock," that rock was found to contain some fissures. Therefore, holes were drilled into the rock to various depths, and these holes were then used as channels through which to distribute grouting under suitable pressure. Inclined holes 2 1/16 inches in diameter were drilled in the floor of the cut-off, and 1½-inch holes were drilled with "Jackhamers" into any side seams encountered in excavating the cut-off trench. The inclined holes—drilled with diamond drills—were carried to a depth of from 15 to 46 feet.

The grouting of the drill holes in any section of the masonry dam was done after a 10-foot lift of concrete had been deposited in that section. The grouting was then carried on as a continuous operation until all holes in a section were completed, unless the response in the adjacent section made it advisable to defer the grouting of some of the holes until after the adjacent section had received the covering course of concrete. The grouting was forced

Top left and bottom right—Activities in the quarry yard where all the ashlar was cut.
Top right and bottom left—Drilling the holes for the baffle anchors.



GILBOA DAM
MAXIMUM SECTION

into the grout pipes by means of air-operated grouting machines using pressures varying from 100 to 30 pounds—the pressure decreasing as the work advanced easterly into the seamy, blocky rock. The grout pipes in the cut-off area were first grouted, and then those in the main dam foundation area followed—both operations progressing easterly. After the machine grouting was completed all pipes were poured full of rich grout. Next any excess water was drawn off and the pipes refilled with rich grout before capping. A longitudinal cross section of the dam and the bed on which it rests shows in a graphic way the manner in which drilling and grouting were done under both the masonry and the earthen sections of the structure.

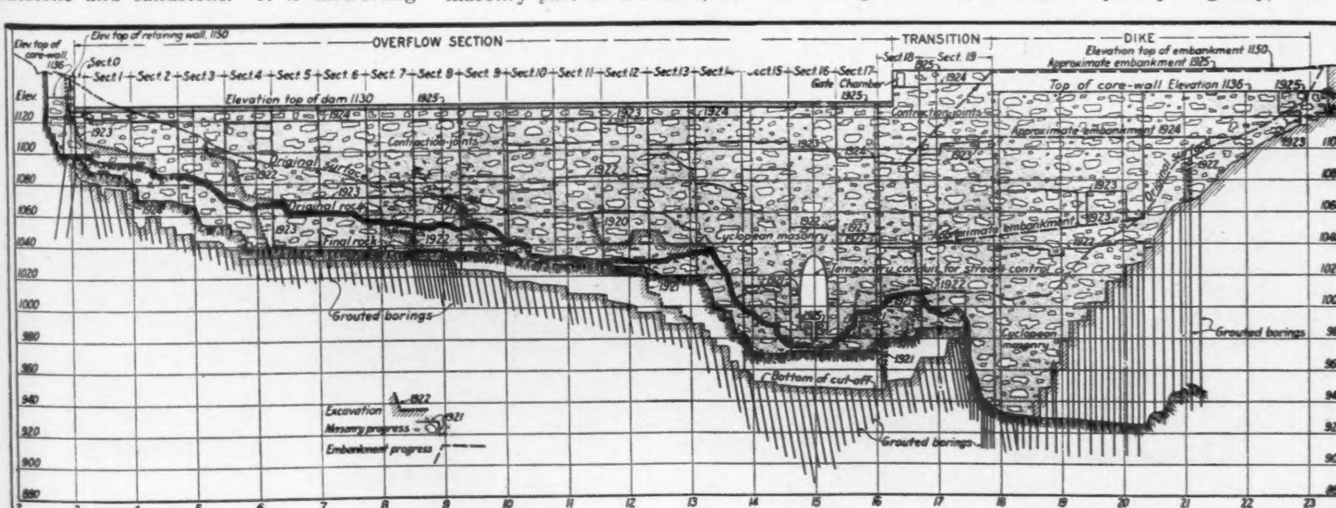
Crushed stone for all concrete—of which 500,000 cubic yards were required in the masonry section of the dam—was obtained from a quarry, on Stevens Mountain, situated 370 feet above and southward of the eastern end of the dam. A crusher plant erected close to the quarry prepared the rock, which was delivered by a cableway to the concrete mixers in the valley below and close to the dam site. The rock obtained at the quarry was a mixture of bluestone and sandstone. It is interesting to recall that sea shells excavated at the quarry indicate that the ocean shore line once reached that far inland—1,500 feet above the present level of the Atlantic.

All cut stone used in facing the masonry section of the dam has been excavated from what is known as the River Quarry—located on Schoharie Creek a few hundred yards below the dam. The stone, which is a form of sandstone, has been proved to be very durable and in some respects to be nearly the equal of granite. This stone, because of the wide difference in temperature between summer and winter seasons, is especially suitable for local use when properly seasoned so as to allow time for the evaporation of its contained "sap." The rock is of the Devonian geological period; and during the quarrying operations numerous specimens of fossil tree stumps were obtained as well as fossil evidences of the foliage of those trees that belonged to a flora that probably flourished something like 300,000,000 years ago.

The dimensional stone was got out by close drilling and by breaking the blocks free from the ledge by the use of plugs and feathers. Substantially 28,000 cubic yards of ashlar have been required in facing and finishing the masonry part of the dam; and all drilling for this purpose has been done with "Jackhamers"—as many as 100 of these tools being employed at one time during the busiest period of the work. Air for these drills and for the surfacing machines set up in the quarry yard was provided by the two compressors already mentioned. Incidentally, it may be recalled, that compressed air was used in the stone yard to drive certain of the hoisting engines.

Besides the uses of compressed air already described, compressed air was variously employed otherwise from start to finish of this great engineering undertaking. To be specific, it was utilized to drive pumps of from 2 inches to 10 inches in size, and to drive virtually all hoisting engines up to 50-H.P. capacity. Compressed air was the motive power for riveting hammers, for forges, and for the "Leyner" sharpeners installed in the blacksmith shop; and it also operated the hammers that drove the sheet piling required at different times during certain parts of the excavating work. Compressed air served to clean rock and concrete surfaces before the placing of further concrete, and it also cleared out joints between the courses of ashlar before the joints were finally poured.

The completion of Gilboa Dam was brought to its climax when the stream-control conduit—through which Schoharie Creek has flowed for many months—was sealed and the waters of that stream began to accumulate within the impounding area. The conduit was progressively closed until only a passageway, 8x8 feet in



Longitudinal section of Gilboa Dam, illustrating the condition of the work at various periods between 1920 and the end of 1925.

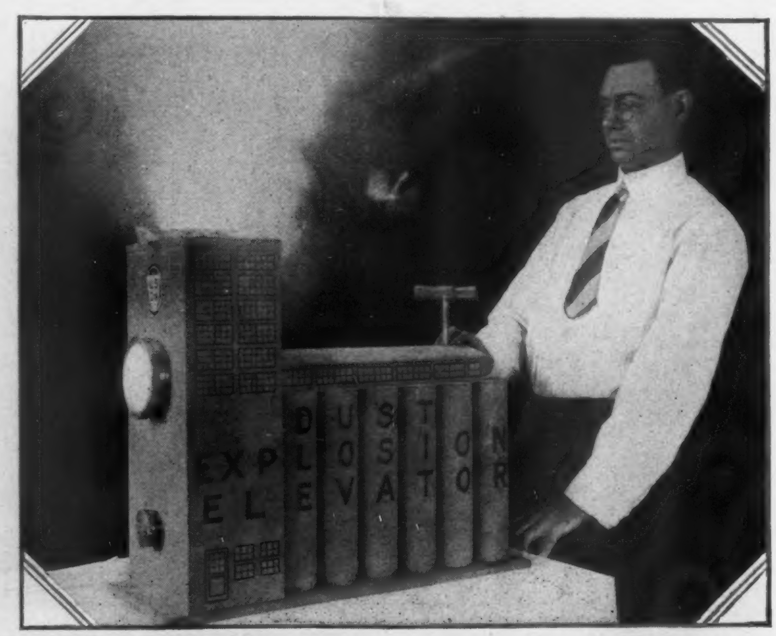
cross section and cut in the bedrock, remained through which the water could escape northward. That outlet was eventually blocked by dropping across its mouth a steel plate or gate. With this in position, it was necessary only to "plug" with concrete, at a leisurely rate, whatever space remained unfilled within the original conduit area. Thus was brought to conclusion a task that called for nearly seven years of work, the mastering of many physical and technical difficulties, and the continual exercise of energy and engineering skill. The dam as it stands today is an accomplishment that reflects much credit upon everyone concerned; and the dwellers within Greater New York have abundant reasons for rejoicing in the finishing of a structure that will contribute generously to their comfort and well-being.

In the years to come, Gilboa Dam will bear evidence to the foresight of the Board of Water Supply of New York City and be, besides, a monument to the man who contracted to build it. Harry P. Nawn, for he it was that essayed to erect the dam, felt that it would be his last great piece of work—the final effort of an active career that had been identified with the consummation of many large public improvements. Indeed, he was certain that he would not live to see the work concluded. In this premonition he was right, for he was stricken on the job and died as he wished to die—with his boots on. Harry P. Nawn always said—"A job must be a good job when finished, because one's work will live after him." The work done on Gilboa Dam has been in accordance with this standard—such being the urge that impelled his loyal personnel even after Mr. Nawn's active leadership was brought to a sudden end.

MODEL TESTS SHOW DANGER OF DUST EXPLOSIONS

EXPERTS of the United States Department of Agriculture, Washington, D. C., have recently perfected a miniature elevator that is used to demonstrate the explosive force of dusts formed in grain elevators, starch factories, flour mills, feed-grinding plants, and, in fact, in most any kind of plant where quantities of dust are continually floating in the air as a result of the commodity handled or the manufacturing processes employed.

In outward form, the model resembles a modern grain elevator; but the interior arrangement is not like that of the structure which it is supposed to represent. Instead, there are housed within the miniature elevator, a small air tank, a sawed-off tire pump with a hose connection leading to the valve of the air tank, a spark coil, and six dry-cell batteries. The equipment is operated from without by means of a push button and a lever.



Miniature elevator devised by one of the research bureaus of the United States Department of Agriculture to illustrate the dangers of dust explosions in milling plants, grain elevators, etc.

When it is desired to create an explosion, the attendant measures out a spoonful of a certain kind of inflammable dust and puts it in a cup on the floor of the model. The next step is to fill the air tank, and this is done by the aid of the pump handle protruding through the roof of the structure. With this done, the air in the tank is released by means of the control lever, thus blowing the dust out of the cup. At the same time, that is, while the dust is in suspension, the electric button is pressed and a spark produced. Instantly, the dust-air mixture is ignited. Through a thick glass window, the observer may note the effect of the explosion and thus determine what would happen in case of a large-scale explosion of the same kind.

FOSSIL PLANT REVEALS ORIGIN OF COAL

GLIMPSES of the interrupted or uncompleted processes of Nature's laboratory are most instructive and revealing. While we know in a general way that our coal deposits were at one time growing plants that have been transformed through the ages, still the processes of transformation are only partly revealed—our information, as a rule, is circumstantial rather than direct.

What may be considered direct evidence of the source of coal is a find recently made, at Harmarville, Pa., of a section of a fossil tree which is now on exhibition in the Department of Mining at the Carnegie Institute of Technology. It is estimated that the fossil is 100,000,000 years old. It represents the top of a tree, approximately 4 feet high, with branches having a spread of about 3 feet. The main branch is about 2 inches thick at the butt. The uniqueness of the discovery lies in the fact that the specimen shows so many details in the way of bark markings, limbs, twigs, and leaves.

SOUND-ABSORBING HANGER FOR COMPRESSORS

THE familiar noise associated with air compressors that are used on electric cars is admittedly pronounced, especially when a train is either standing still or traveling at low speed. To many passengers, this chug-chug of the compressor is annoying; and, in consequence, railroad companies are making efforts

Courtesy, Electric Railway Journal.

Rope-laced compressor suspension. The purpose of this mounting is to lessen or to eliminate the sound of running compressors carried under the bodies of railway cars.

to prevent it. Recently, the Buffalo & Erie Railway, at Fredonia, N. Y., experimented with a rope-laced suspension device which, according to the *Electric Railway Journal*, has reduced by 80 per cent. the audible vibration transmitted to car bodies.

Like many useful inventions, the hanger is of simple construction. It consists of two different-sized metal rings made of round, 1-inch rods. Three supporting lugs are welded onto each ring. The smaller ring is placed within the larger one and laced to it with a trolley rope. This rope is specially treated with a mixture of linseed oil and paraffin to prevent the deterioration of the rope through exposure to the weather. Before the rings are laced together they are taped, so as to protect the rope from chaffing—that is, to reduce wear and tear.

The lugs on the outer ring are bolted to the car body and the lugs on the inner ring are bolted to the compressor housing. Safety lugs are also attached to the inner ring, and these extend sufficiently over the outer ring to provide plenty of space for the rope lacing.

In 1925, the world's organized air routes had a length of 31,000 miles, and the recorded flights over those lines aggregated 14,382,900 miles.

Oil Engine Effects Notable Economies

By C. K. WILDMAN

FUEL-OIL engines as economical prime movers are frequently so proclaimed in general terms, but the thing that counts most with a possible purchaser is something in the way of specific information. The following article details the experience of a machinery manufacturer whose plant is so situated that the management must give particular heed to power costs because the load is a variable one.

Early in 1900, William Fischer founded a small machine shop in an unpretentious building on Vine street, Philadelphia. The business was mainly devoted to repair work on various types of machine tools or other special machinery requiring skilled workmanship and a high degree of precision. Conscientious and exceptionally good service, combined with sound business judgment, led to a contract calling for the building of fish-netting machines. These machines were of ingenious design, and required great care and skill in manufacturing them on a production basis. Each machine had to be able to tie 1,500 knots a minute. This contract was the first job that put the Fischer Machine Company to a test in turning out machines in large numbers. Success in that case won for the company a contract to build the original model of the well-known Fox gun and to provide the jigs and fixtures needed in manufacturing this gun in quantity.

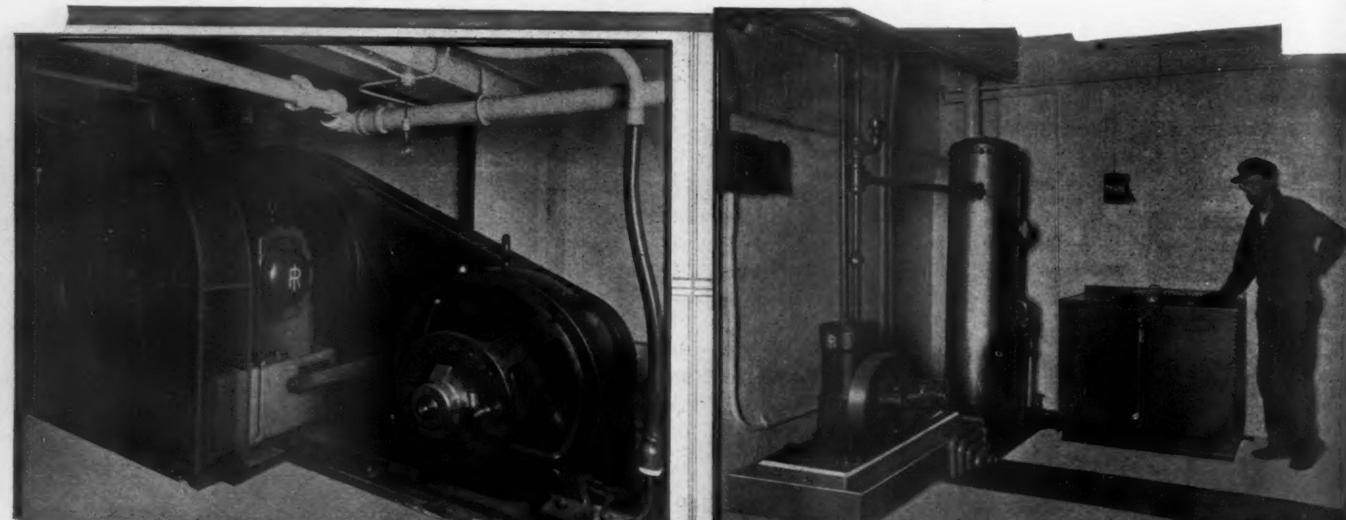
By 1910, the Fischer Machine Company was installed in its present home on North 11th Street, Philadelphia, Pa.; and the construction of special machinery grew apace—each new contract calling upon the inventive genius of Mr. Fischer and the experience and the skill of his trained shopmen. Because of its enviable record, the Fischer Machine Company, after the United States entered the World War, was entrusted with the very exacting work incidental to the making of gun sights and special radio equipment.

One of the achievements of the company, of which Mr. Fischer is justly proud, was the execution of a contract which involved the manufacture of delicate scales for the mint of the Chinese Government. These scales were built to show a difference in weight of 1/16th of a grain—that is to say, the weight of a hair would disturb the balance of the scales. The mint in which these scales are to be used will be, so it is said, the largest and most complete plant of its kind in the world. It is to be located in Shanghai, and its erection is now being supervised by an expert of the United States Mint.

In addition to the various special machines constructed from time to time by the Fischer Machine Company, that concern has developed and manufactures on a large scale what is known as the Fischer oil groover. Briefly, this machine tool can cut oil grooves of nearly any desired pattern in bearings of all sizes up to and including those 15 inches in diameter and 18 inches in length. Grooves, whether straight or spiral—either internal or external—are made in a "quick set-up" and can, therefore, be produced at low cost. Necessary change gears are provided for cutting single, double, or quadruple spirals.

The years of expansion and increased production brought with them the eternal problem of how to obtain cheaper power. Mr. Fischer decided that the conditions under which his plant operated made it desirable that he should generate his own power, instead of buying it, and employ for that purpose an internal-combustion engine as a prime mover. Accordingly, he first installed a 25-H.P. gas engine, which soon proved inadequate. He then purchased a more economical unit—a 60-H.P. oil engine of the semi-Diesel, or low-compression, hot-head type. Two direct-current generators, belted over from each flywheel of the engine, supplied light and power, respectively. This engine continued in service until the fall of 1925. All this while,

Left—Planing twelve machine frames in one setting. Right—Part of the lathe department. Bottom—Assembling a group of Fischer oil groovers.



Left—The 50-H.P. oil engine recently installed in the plant of the Fischer Machine Company. This engine is the primary source of all motive energy used in the establishment.
Right—Air for starting the oil engine is furnished by a Type Fifteen compressor which maintains the air at a suitable pressure in an associate receiver.

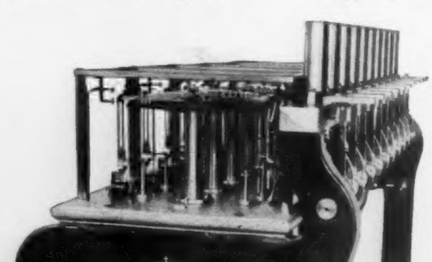
Mr. Fischer stood ready to purchase central-station power if he could save money; but a careful analysis of his plant conditions convinced him that it would be to his advantage to buy an oil-engine generator when it should become necessary to provide a newer and larger power unit.

The man who had originally interested Mr. Fischer in oil-engine power and who had sold him the first units installed in his plant was the late W. T. Price, under whose license the Ingersoll-Rand Company is now building oil engines. Price had, after years of investigation, developed a means of injecting the fuel in an oil engine through two opposed spray nozzles into a specially designed combustion chamber without the use of highly compressed air, and of burning the fuel completely with full Diesel economy without any extraneous source of heat —such as hot bulbs, hot plates, etc.—and with the use of only moderate initial compression in the cylinder. This was a long step towards simplification, and did away with the complicated 3- or 4-stage injection air compressor, commonly used with Diesel engines, which is a source of much vexation and trouble.

Price had in the meantime associated himself with the Ingersoll-Rand Company; and it was Mr. Fischer's privilege to witness the first tests of the engine built by that company and incorporating Price's basic ideas. The amazing performance of the engine, combined with its extreme simplicity, so impressed Mr. Fischer that he purchased early this year—after making a thorough investigation of several other types of oil engines—an Ingersoll-Rand Type "PO" oil engine rated at 110 B.H.P.

The "PO" engine in question is of the 4-cycle, horizontal, single-cylinder type. The unit installed in the plant of the Fischer Machine Company has a bore of 17 inches and a stroke of 19 inches, and makes 257 revolutions a minute. When operated at its rated load of 110 B.H.P., the combustion of the fuel is substantially as just described, and the resulting economy permits the manufacturer to conservatively guarantee the engine not to burn more than .42 pound of fuel oil at full or at three-quarter load, and .45 pound at half load. This means that the engine will run at full load on approximately 6 gallons of fuel per hour. The lubricating system has been so well designed, with an entirely enclosed crank case, and the heat is so well dissipated that the engine builder guarantees that not more than 1 gallon of lubricating oil will be consumed per 2,000 rated horsepower-hours.

The building occupied by the Fischer Machine Company is a concrete-and-brick structure of 4 stories and a basement. The power plant is located in the rear of the basement. As it was decided to permit the old semi-Diesel engine to remain in place as an emergency unit, the new engine was set up in an adjoining part of the basement. In order to build the foundation for this engine it became necessary to remove several inches of very hard concrete floor. To expedite this work, and as a favor to Mr. Fischer, the Ingersoll-Rand Company furnished one of its well-known Type Twenty portable air compressors, a CC-35 paving breaker, and an H-156 clay digger—all mounted on a Ford truck and used ordinarily for demonstrating purposes. By utilizing this air-driven equipment instead of hand labor, it was possible to save several days' work and many dollars.



This coin-weighing machine is so sensitive that it will register a difference of one-sixteenth of a grain. One hundred and twenty of these units were built for the Chinese government.

To conserve space, it was decided to operate the direct-current generator through a short-belt drive with an idler attachment. This arrangement not only saved space and provided a flexible drive, but it also permitted the use of a high-speed generator which cost considerably less than a direct-connected, slow-speed generator. To supply 220-volt current for power and 110-volt current for lighting there is a small balancing set; and even with a widely fluctuating load, such as results when the direction of the large planers is reversed, there is hardly any perceptible flicker in the lights.

To insure an accurate check on the amount of fuel used, the engine-room is equipped with a 100-gallon day tank. From this tank the fuel pump on the engine takes its suction. A small electrically operated pump fills the day tank from the main oil tanks; and a glass gage indicates the quantity of oil consumed throughout any period of time and under any load conditions. The load on the engine of course varies with shop operations, but Mr. Fischer estimates the average to be about 75 B.H.P. at the engine.

Actual figures of fuel consumption bear evidence to the really remarkable operating economy of the unit: during a working period of 226.75 hours only 783 gallons of fuel were consumed. As the fuel oil costs but 6½ cents delivered, the average fuel cost to operate the entire plant during the given period was only 22½ cents an hour, or $51 per month.

Spectacular Salvage of Sunken Submarine

Refloating the United States Submarine "S-51" an Outstanding Example of a Unique Use of Compressed Air

By ROBERT G. SKERRETT

GRIT, perseverance, and the will to win despite tremendous odds were the human factors that recently brought to a successful climax the months of effort devoted to the raising of the U. S. Submarine *S-51*. The outcome is one more splendid example of what the "navy spirit" can make possible when confronted with a desperately difficult task.

This tribute to the men that went down to the sea bed, 132 feet below the surface, or who battled often with the Atlantic when that ocean was in an angry mood, in nowise detracts from the skillful engineering work done to make the refloating of the *S-51* possible. Much of that work was of a preparatory nature that extended over a period of months, and involved not only careful planning but a studious anticipation of every contingency that might arise during salvage operations in that storm-swept area of the North Atlantic. These preparations and their successful application were under the immediate supervision of Lieutenant-Commander Edward Ellsberg who, in commercial life, would be termed the wrecking master.

The recovery of the stricken craft reflects great credit upon everyone that had to do with that dangerous and extremely trying job. And it is generally admitted that none of the mechanical facilities used would have been effective if the courage of the men had failed—had their will to fight on faltered for an instant during that protracted and exhausting struggle. Out of a total of 27 divers engaged at various times in the work, 12 were more or less seriously incapacitated before the task was finished—such was the severity of the physical stresses to which they were frequently subjected. Every red-blooded American can well be proud of what was done by the men of the navy at the scene of the disaster that carried the *S-51* to her watery grave and suddenly snuffed out the lives of 33 of her personnel.

BRINGING the sunken submarine "S-51" up from a depth of 132 feet in the open sea established a new record in maritime salvage that is likely to go unchallenged for some time to come.

In March of 1915, the U. S. Submarine "F-4", a craft of only 240 tons displacement, foundered outside of Honolulu and went to the bottom in 306 feet of water. That boat was ultimately recovered after she had been forcibly dragged along the sea bed into sheltered waters only 45 feet deep, and then raised with pontoons. The "S-51" was brought to the surface by a single lift, and the dead weight to be overcome totaled 1,001 tons.

Ultimate success hinged upon the skillful use of compressed air and the unflagging display of courage on the part of the men that risked their lives daily in the deep.

The submarine was running in surface trim on the night of September 25, last year, when she was struck by the *City of Rome*, then traveling at full speed. The steel stem of the merchantman cut into the *S-51* just forward of the conning tower, on the port side—the resulting V-shaped gash extending from the deck downward nearly to the keel and inboard almost to the center line of the submarine. Through that gaping wound the sea rushed into the *S-51*, quickly destroying her reserve of buoyancy and sending her headlong to the bottom.

Although the submarine foundered after nightfall, in the open sea, 14 miles eastward of Block Island, still navy divers were on the scene of the catastrophe and down alongside the wreck within the relatively brief interval of 14 hours—so speedily and effectually were steps taken to locate the unfortunate craft at

United States Navy, Official Photograph.

The "S-51," viewed from the forward port side, shortly after the dry dock at the Brooklyn Navy Yard was drained.

her unmarked position more than 21 fathoms below the surface.

Even though no answering signals were received by the divers, still the navy made desperate efforts to raise at least one end of the boat—hoping against hope thus to save life, if life still lingered among the men within the *S-51*. For this purpose, 2 large floating derricks were requisitioned; but they were unable to lift the undamaged stern. Those salvage craft failed for two reasons: they could not exert a sufficient lift to break the grip of the sea bed; and weather conditions were generally unfavorable to the employment of salvage vessels of that sort working in so exposed a position.

When the floating derricks proved unequal to the task, Lieutenant-Commander Ellsberg decided to approach the problem in a different way: that is, to give the *S-51* as much internal buoyancy as possible so as to reduce her submerged dead weight of 1,001 tons and to utilize additional buoyancy, applied externally, through the medium of submergible pontoons —the pontoons to be placed symmetrically on both sides of the submarine, each flanking pair of pontoons being tied together by 2 slings or loops of chain passing beneath the keel of the *S-51*. To prevent confusion, we shall first take up the measures adopted to give the submarine internal buoyancy by getting rid of some of the water within her flooded compartments and other structural subdivisions.

To drain parts of the interior of the *S-51* two courses were open to Lieutenant-Commander Ellsberg: he could either drain the vessel by pumping or lighten her by forcibly expelling some of the water inside of her—utilizing compressed air to effect this expulsion. The U. S. S. *Falcon*, and the submarine mothership *Vestal*, which formed part of the salvage fleet, carried between them a total of 12 electrically driven submergible pumps, such as did excellent work abroad in salvaging ships during and immediately after the World War. Each of these 4-inch pumps is capable of raising water to the surface when the pump is submerged to a depth of 80 feet—operating in this respect differently from the ordinary wrecking pump which can work only above water. On the face of it, submergible pumps could not be utilized at a depth of 132 feet.

To overcome this limitation, it was thought the pumps might be used by placing them on the submarine and connecting them so that they could help in unwatering some of the flooded compartments after those compartments were suitably sealed—the difference in effective pumping head, a matter of 50 feet, to be compensated for by forcing compressed air into the compartments for the purpose of reducing, in effect, the hydrostatic head under which the pumps would have to work. This procedure was abandoned because of a weakness in the equipment of the submergible pump. That is to say, it is necessary that all couplings in the cable through which electric current reaches the pump motors shall be kept absolutely watertight: any leakage at any coupling would cause a short circuit and instantly put the pump out of service. Therefore, even though the pumps perform satisfactorily most of the while, still there would always be the chance that one or more of the electrical cable couplings might leak at a crucial moment and halt the raising of the submarine when everything else promised well. Accordingly, Lieutenant-Commander Ellsberg determined to center all efforts on the use of compressed air alone to give the sunken craft the needful internal buoyancy and to control with the same medium the pontoons that were to aid in the recovery of the submarine.

Salvage operations of a more or less preparatory nature were carried on from October 15 to December 1, 1925, when work was stopped because of the approach of winter storms. The salvors returned to the scene of the disaster on April 23 of the present year, and continued in their efforts until the submarine was lifted to the surface on July 5. Between December of the year gone and April of the current year, the wrecking master perfected his plans and assembled the various equipment which he deemed essential to the successful execution of his very difficult task. Among the things developed by him the while was a metal-cutting torch that could be used underwater. This torch is an improvement upon a subaqueous torch devised by the French during the World War, but which was never a success until Lieutenant-Commander Ellsberg took it in hand. He has reason for pride in what he has done to bring to its present state an apparatus which played an important part in the recovery of the *S-51*.

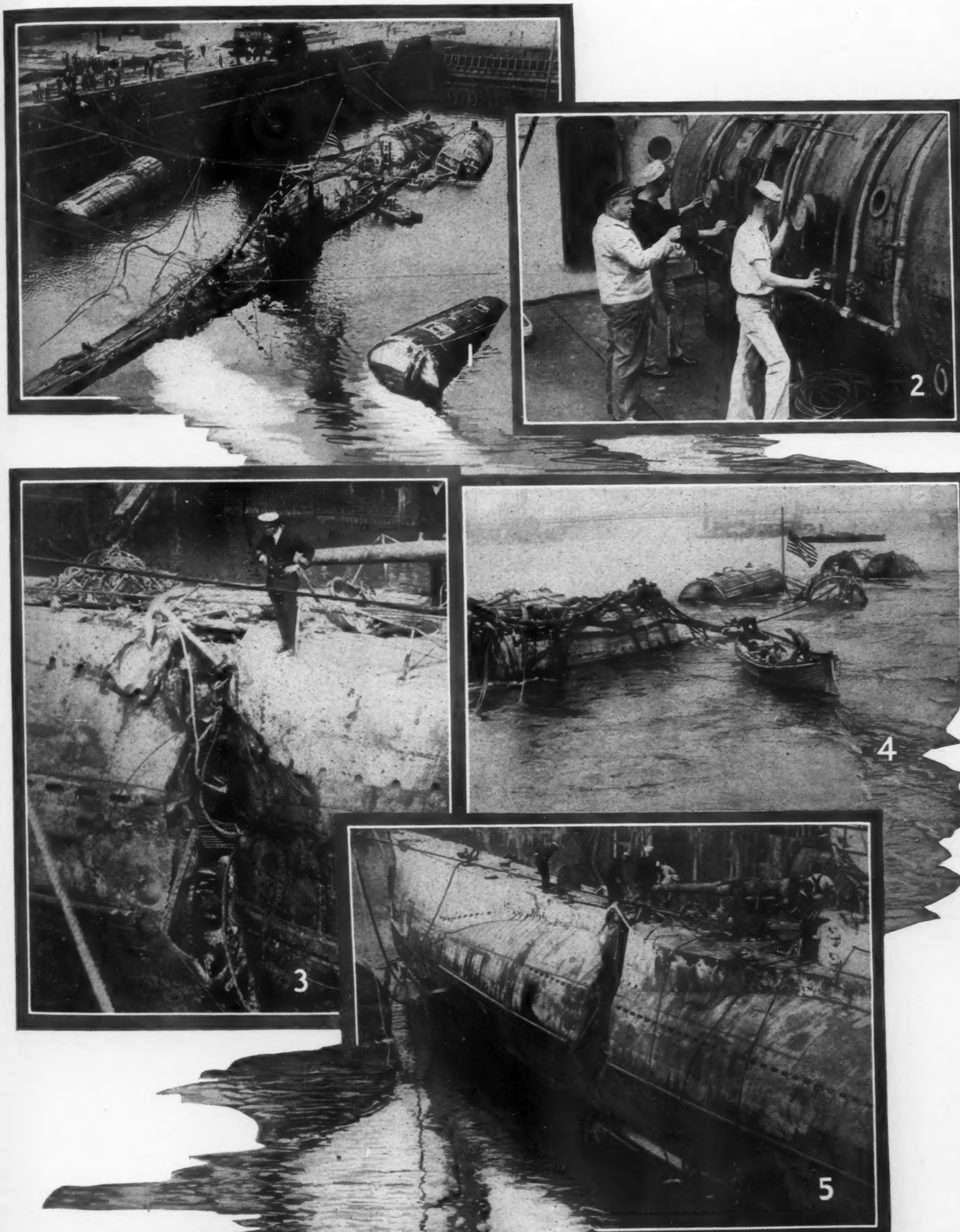
Space does not permit a detailed description of the torch. For the present we shall say only that the burning flame was produced by a combination of oxygen and hydrogen—the water being kept away from the flame by a screen or envelope of compressed air that can be adjusted to offset the hydrostatic pressure at the working depth. The torch can be lighted at any depth underwater by an independent and simple electric lighter, consisting in the main of 2 carbon points held just far enough apart to produce a spark when current is turned on.

Submarines are so constructed that their hatches, ventilators, outboard valves, and other vents are automatically sealed tighter when exposed to the pressure of the enveloping sea. This is a safeguard against leakage when running submerged. These passageways, on the other hand, are not designed to resist superior internal pressure seeking an escape outward. Therefore, before compressed air could be applied within the *S-51* to drain flooded compartments, by forcing water down and out through existing openings or vents cut for the purpose, it was necessary to seal certain of her valves so that they would remain tight when pressure was brought to bear upon them from within; also, the regular hatches over the main compartments that were to be drained had to be removed and other hatches fitted in their stead that would be able to resist both internal and external pressure, if needful. This meant that the divers would have to work on the wreck both inside and outside of her at a physically exhausting depth and under conditions that would often be perilous.

Probably the hardest part of the preparatory work had to do with sealing the ventilating system, by which fresh air was delivered to the main compartments when the submarine was in light trim at the surface. Extending fore and aft outside the pressure-resisting hull and housed within the superstructure, the *S-51*—like all her sisterships, has a heavy 12-inch copper main fitted with a valve opening into the top of each compartment for the discharge of fresh air. Steps had to be taken either to close these valves against internal pressure or to block them off in some other way. In one case—that having to do with the ventilating duct lying over the motor room—it was possible to deal with it only by removing a section of the superstructure steel deck. The plating was cut away with the underwater torch; and a length of the ventilating main, thus exposed, was unbolted and lifted to the surface. The exposed ends were blanked or closed by steel disks bolted to the flanged openings. This work as well as other jobs required the handling of considerable weights, which subjected the hearts of the divers to dangerous stresses when already toiling under abnormal and exhausting pressure. The divers were fully alive to the bodily risks they ran, but they faced those hazards cheerfully for the sake of ultimate success.

In the engine-room and in the control-room, the ventilating main was so built in that the only way to dispose of it was to close, from within the boat, each of the associate 14-inch valves. Even so, special means had to be taken to make sure that these valves would remain firmly seated when the compartments were charged with buoyant air seeking an escape outward by any passage that might be open to it. Each big ventilating valve had fitted to it a small 1¼-inch drainage valve to take care of accumulating condensate. These small valves were removed after the big valves were seated by the divers, and to each of these drainage outlets was connected a rubber hose reaching down from the U. S. S. *Falcon*, whose two 2-stage compressors furnished most of the air used in salvaging the *S-51*. The upper end of each 250-foot length of hose was successively connected with a tank having a capacity of 5 cubic feet.

This tank was filled with a fluid but quick-setting mixture of cement that would harden rapidly underwater; and three times, in the case of each of the 2 ventilating valves, the tank was filled and its charge sent down into the submarine under an impulse of air at a pressure of 150 pounds. Each valve has an internal capacity of 2½ feet, and the cement, therefore, displaced the water and occupied not only the space in the valve but likewise a section of the connecting ventilating duct. The grout consisted of 5 parts of "Lumnite" cement—lately produced by the Atlas Portland Cement Company—and 2½ parts of water. The choice of this cement was the outcome of much experimenting by Lieutenant-Commander Ellsberg, because the conditions



© International Newsreel Photos.

Fig. 1—U. S. Submarine "S-51" after reaching the Brooklyn Navy Yard and before the dry dock was pumped out.

Fig. 2—Testing the valves of the recompression chamber mounted on the U. S. S. "Falcon" and used to gradually restore divers to atmospheric condition after returning from their deep and dangerous work on the sunken submarine.

Fig. 3—Lieutenant-Commander Ellsberg viewing at close range the gash cut in the side of the submarine by the steel stem of the "City of Rome."

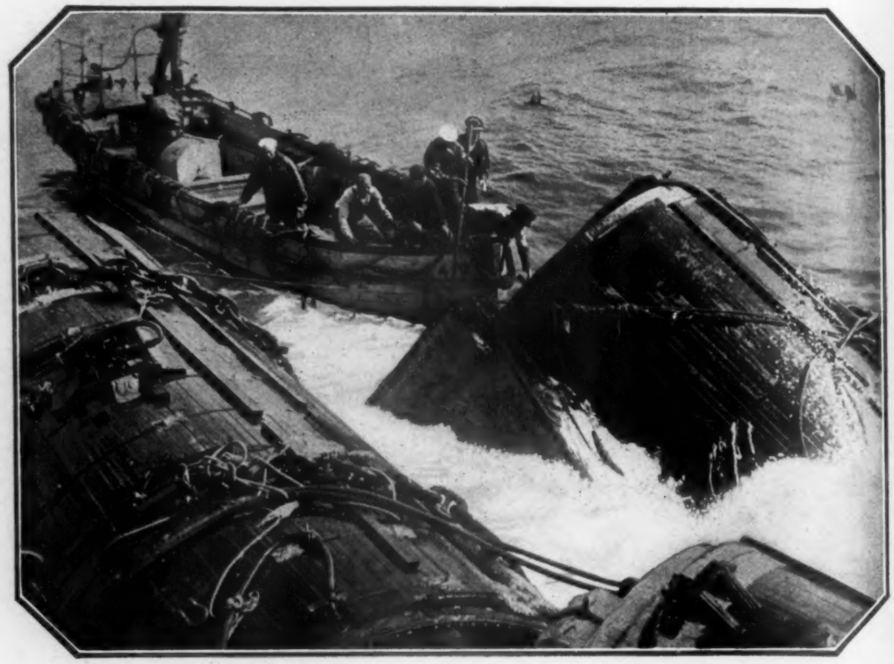
Fig. 4—The "S-51," while grounded on a reef in the East River, when near the end of her journey of 150 miles.

Fig. 5—This picture, taken when the dry dock was nearly drained, shows clearly the angle at which the submarine was struck by the steamship. Through this gap the sea rushed in and quickly filled the "S-51" from bow to stern.

under which the stuff had to travel and to act were exacting. The cement effectually plugged the valves; and no leakage occurred when the compartments were filled with air at a pressure of 58 pounds—the pressure required at a depth of 132 feet to slightly exceed the opposing pressure of the sea. In sealing the ventilating valves in question, the wrecking master displayed the same resourcefulness evidenced by him in his preparations for other phases of the undertaking.

Now let us see how the submerged dead weight of the submarine was reduced by giving her an internal cumulative buoyant moment of 500 tons. Owing to the ragged and extensive nature of the gash in the submarine's side, no time was wasted in trying to close that wound or to seal the 2 main compartments thus opened to the sea. Instead, efforts were confined to making ready 3 of the main compartments abaft the injury, as well as 15 lesser subdivisions, so that they could be filled with compressed air. The lesser subdivisions were 6 of the main ballast tanks, 6 of the fuel-oil tanks, the forward trimming tank, the tiller room, and a compensating tank adjacent to the forward torpedo tubes.

In each case, an air connection had to be made at the top and an outlet provided, if none existed, for the escape of water that was to move outboard under the urge of a superposed and increasing volume of compressed air. Where Kingston valves in the bottom of tanks could be reached or used, it was necessary only to open those valves to provide outlets for the water; but where those valves could not be opened, or where vents did not exist for a kindred purpose, then holes were burned in the bottom of the hull with the underwater torch. In passing, let it be said here that after each one of the minor subdivisions was drained pneumatically the intake valve was closed, and the air hose disconnected. This procedure was made possi-



© Herbert Photos, Inc.
When the bow of the "S-51" rose unexpectedly to the surface on June 22 and was sunk again to the sea bed after some of the pontoons broke loose.

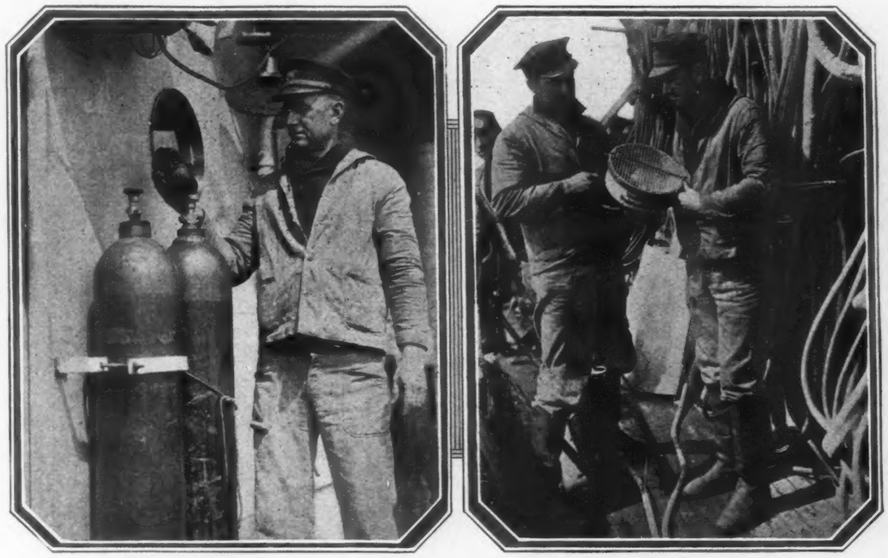
ble because of the character of those chambers that were so constructed that they would hold the compressed air indefinitely.

The three main compartments were vented by non-return valves fitted at the bottom ends of 4-inch discharge lines—one such pipe, with a pendant hose length, being attached to the underside of the special salvage hatch leading into each of the main compartments. Each 4-inch line also served the purpose of a "spill pipe" for the water in that particular compartment, owing to the fact that the lower end of the pipe reached to the bottom of the compartment. Thus the air vents served as safety valves and as passages through which the

© Herbert Photos, Inc.
Men aboard the U. S. S. "Vestal," one of the salvage fleet, overhauling air hose and telephone cables used by the divers working upon the sunken "S-51."

flooding water could be expelled when draining the compartments. In theory, all this sounds comparatively simple, but the making of these preparations and the installing of the apparatus took time and called for infinite care and the running of many risks.

The wrecking master had also to provide relief for the pent-up and buoyant air as the submarine rose surfaceward—failure to do this might have invited disappointment if not disaster at the last moment. The hydrostatic pressure at a depth of 132 feet is a shade less than 58 pounds; and the air entered each compartment at a pressure providing just sufficient excess to overbalance the sea pressure and to overcome the inertia of the water inside the compartments or tanks to be drained. As the boat mounted surfaceward this difference in favor of the air would naturally increase; and, unless provision were made for the prompt escape of much of the excess air, an explosive or disruptive force might develop that would blow off hatch covers or even cause the seams of the hull to open up and to permit the craft to fill again when the air had escaped. Therefore, the wrecking master had to see to it that the openings provided for the outward passage of the water should be large enough for the water to escape freely so that the air would have a chance to expand and to drop proportionately in pressure, or, in lieu of that, he had to fit check valves that would lift and blow off when the air pressure exceeded the external water pressure by a predetermined amount. Each large compartment had a check or safety valve of this sort that operated when the buoyant air had a pressure of ½ pound above that of the sea at any point during the ascent from the bottom to the surface. From each point where air was forced into the *S-51* a connecting length of hose led up to the bridge of the



© International Newsreel Photo. © Herbert Photos, Inc.

Left—Flasks of helium aboard the U. S. S. "Falcon." This gas was used successfully in safeguarding the divers against "bends" when working 132 feet below the surface.

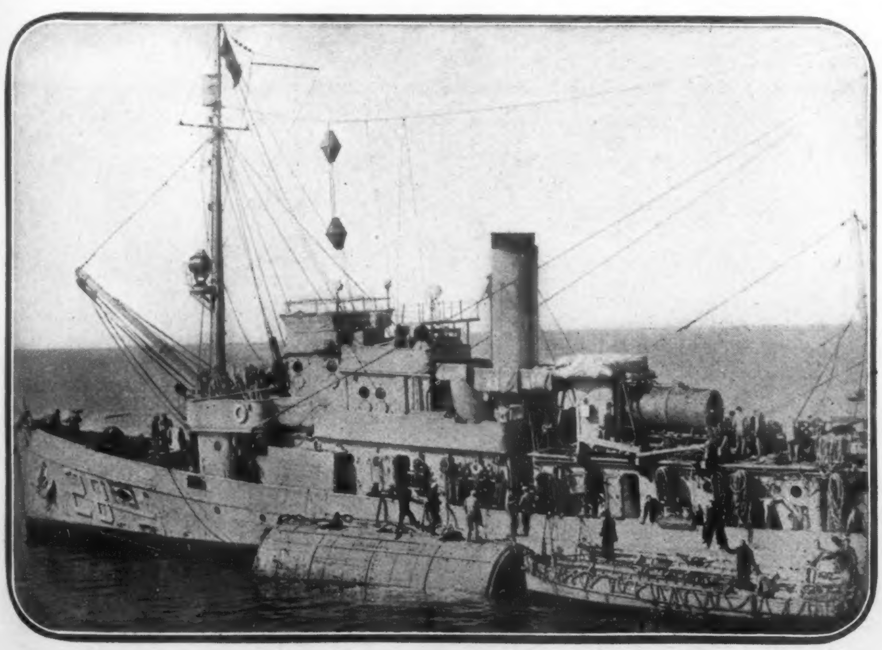
Right—One of the 1,000-watt submarine lamps that illumined the wreck of the "S-51" so that the divers could see to do the work expected of them when natural light failed them in the ocean's depths.

U. S. S. *Falcon*. On the bridge of that salvage craft was an array of manifolds and gages, so that the wrecking master could manipulate them at will and know precisely what was taking place within the submarine as he gave her buoyancy by forcing water out of her. Similarly, other lengths of hose were led to the 8 pontoons that exerted externally the additional buoyancy needed to break the *S-51* free from the grip of the sea bed and to bring her to the surface. All told, a total of 20 separate leads of hose—12 of them 1¼ inches in diameter and 8 of them 1 inch in inside diameter—linked the *Falcon* with the submarine and the pontoons for the purpose of distributing compressed air. Of these, 16 leads carried air to the 8 pontoons. In short, there was a total of 6,000 feet of hose used for this purpose.

The same compressors that furnished buoyant air to the submarine and the pontoons also provided essential air to the divers—the compressors delivering air to a large receiver in which the air was stored at a pressure of 150 pounds and thence distributed directly to the divers far below on the sea bed or at work within the *S-51*. Each diver, as a safety provision, was connected with the *Falcon* by 600 feet of hose; and the internal friction of this hose cut the pressure down to a point where the pressure of the air was not much above that required where the diver was engaged. The object in giving the diver 600 feet of hose was to insure him an ample lead should the *Falcon* break away from any of her steadying lines and swing around to a new and more remote position.

As a precautionary measure, the navy built 10 submergible pontoons; but only 8 of them were required for the work of raising the *S-51*. The internal construction of the pontoons was much the same as that used in building submarines—the object, of course, being to give the pontoons ample strength to meet conditions at the sea bed 132 feet below the surface and to make them rugged enough to withstand rough treatment when exposed to battering seas. Each pontoon was built of heavy steel plating, was 32 feet long, had a diameter of 13 feet, and was sheathed with a protecting coat of 4-inch planking. Each pontoon was capable of exerting a net lift of 80 tons.

As some of our sketches show, the pontoons were provided with flood valves through which water could enter and leave the pontoons accordingly as air was permitted to escape from them or air was blown into them to force contained water outward. At two points, extending from top to bottom, each pontoon had hawse pipes through which chain could be passed to form the slings by which the pontoons were attached to the submarine. Each pontoon had also a release valve that lifted whenever the air pressure within the pontoon was 10 pounds higher than that of the outlying water.



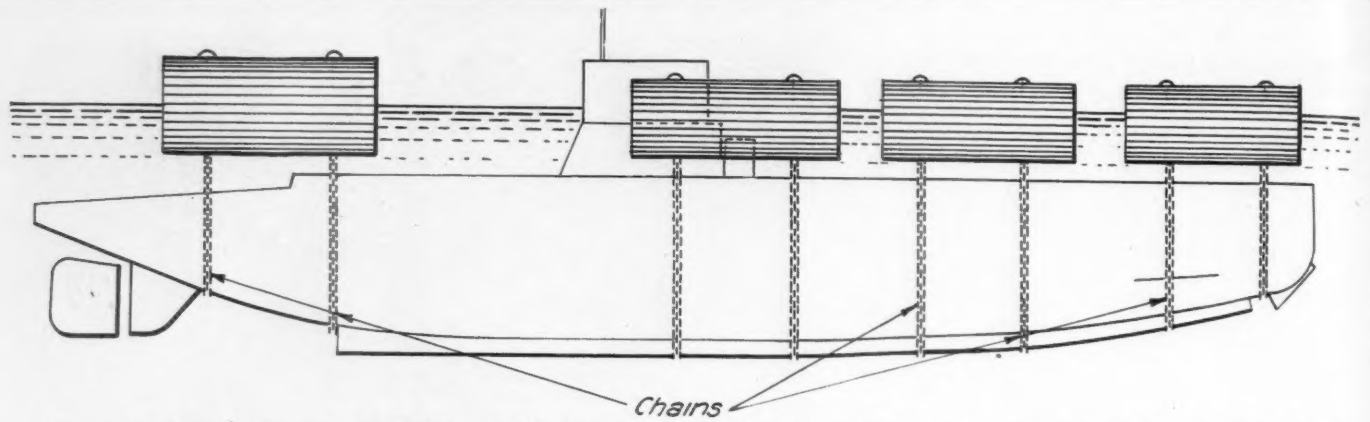
© Herbert Photos, Inc.

The U. S. S. "Falcon," the salvage craft that played an outstanding part in the refloating of the "S-51" and in getting the ill-fated craft to the Brooklyn Navy Yard after a trip of 150 miles.

As already mentioned, 8 of these 120-ton pontoons were used to assist internal buoyancy in breaking the *S-51* free from the sea bed. Six of the pontoons were concentrated forward of mid-length for the purpose of overcoming the dead weight of the wounded and flooded section of the craft, while the 2 remaining pontoons exerted their buoyancy in raising the stern. The 6 forward pontoons were allowed to fill with water until they had just dead weight enough—and yet a small amount of residual stability—to carry them to the sea bed at points within 3 feet of their predetermined positions. When ready, there was an interval of only 8 feet between the neighboring ends of the 3 pontoons on either side of the vessel.

Anyone unfamiliar with salvage work of that nature could not begin to visualize the difficulties that had to be overcome to effect the prescribed arrangement of these large bodies that were sensitive to a seaway and as hard to control as restive elephants. They had to be handled so that they would not smash one another in boisterous weather, and it was equally important that they should not damage the submarine in settling to their proper places 132 feet underwater. The men that had to manage them faced sudden death or cruel injury on many occasions. But before the pontoons could be linked together so that their chain slings would cradle the *S-51* it was necessary to pass the connecting and sustaining lengths of chain beneath the buried keel of the submarine.

When the *S-51* foundered, her weight and the momentum with which she hit the bottom



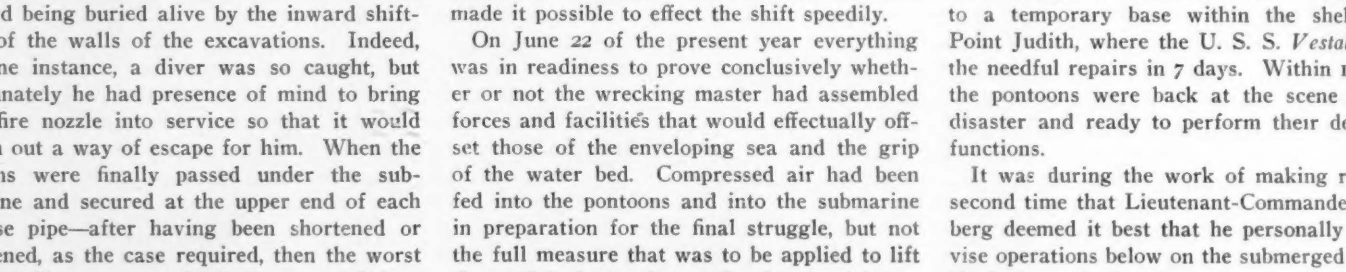
It was in this way that the eight submergible pontoons, attached to the "S-51" by chain slings, lifted the submarine from the sea bed and sustained her while she was being towed from the scene of the disaster to the Brooklyn Navy Yard, 150 miles away. The buoyancy of the pontoons and of the submarine was maintained the while by compressed air delivered to the boat and the pontoons through connections with the U. S. S. "Falcon."

caused her to embed herself to a depth of 7 feet in the sand and clay that formed the bottom. The sea floor was so hard that the divers, even with their heavy lead-soled shoes, could walk upon it without leaving the faintest footprint. Tunnels had to be dug in the sea floor at three points under the *S-51* so that chain slings could be placed beneath the wreck. Divers did this excavating work with powerful streams issuing from the nozzles of fire hose sent down to the sea bed. The jobs were extremely hazardous ones, and the divers risked being buried alive by the inward shifting of the walls of the excavations. Indeed, in one instance, a diver was so caught, but fortunately he had presence of mind to bring the fire nozzle into service so that it would wash out a way of escape for him. When the chains were finally passed under the submarine and secured at the upper end of each hawse pipe—after having been shortened or tautened, as the case required, then the worst of the toil was over and only lesser and lighter tasks remained to be finished before sending down from the surface the compressed air that was to break the final hold of the sea bed. It was in one of the concluding operations in connection with securing the slings to the pontoons that the underwater torch performed its most difficult task.

Each sling was locked in position at the upper end of each hawse pipe by a 4x4-inch nickel-steel bar passed through a link in the chain after the regular 2½x2½-inch stud in that link had been cut out by the underwater torch. On one occasion, it was necessary to burn through a 4x4-inch locking bar in order to remove it when readjusting the sling. Again, the subaqueous torch did the work and made it possible to effect the shift speedily.

On June 22 of the present year everything was in readiness to prove conclusively whether or not the wrecking master had assembled forces and facilities that would effectually offset those of the enveloping sea and the grip of the water bed. Compressed air had been fed into the pontoons and into the submarine in preparation for the final struggle, but not the full measure that was to be applied to lift the craft in her entirety. On that fateful day, Nature did her best to upset Lieutenant-Commander Ellsberg's carefully laid plans, and stormy winds kicked up a tempestuous sea. The motion of the water was transmitted 132 feet downward, overcoming the "suction" of the sea bottom. The motion caused the pontoons to sway and the submarine to rock so vigorously that the more buoyant bow broke loose from the sand and clay and mounted to the surface. The bow was purposely sunk again a while later when 2 of the stern pontoons broke away and went adrift, while the 4 bow pontoons were being badly battered and damaged by the storm. The derelicts were recovered and the other injured pontoons were brought to the surface and then towed to a temporary base within the shelter of Point Judith, where the U. S. S. *Vestal* made the needful repairs in 7 days. Within 12 days the pontoons were back at the scene of the disaster and ready to perform their designed functions.

It was during the work of making ready a second time that Lieutenant-Commander Ellsberg deemed it best that he personally supervise operations below on the submerged wreck. He had purposely taken a course in diving in order to meet such an emergency. He believed he could help his men best by being with them; and despite the grave risks he ran he went down to a depth where only experi-



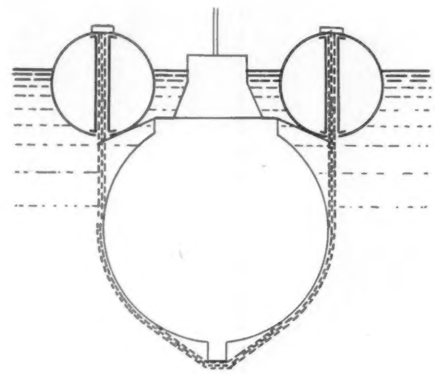
© Herbert Photos, Inc.

The "S-51," supported by pontoons, being towed to the Brooklyn Navy Yard. A sistership, the "S-50," accompanied the salvage fleet for the purpose of rendering assistance if need be.

enced and comparatively few divers are qualified to go. Lieutenant-Commander Ellsberg speaks lightly of this part of his work on the *S-51*, but his courage then is quite in keeping with the spirit shown generally by the men engaged in that extremely hazardous undertaking. He felt that he had to set an example at a critical time when disappointment was subjecting the men to a severe stress. They had labored for months aboard a crowded ship; they had faced many perils cheerfully; and they had endured without complaint time and again being tossed about in a small craft in storm-swept seas. The problem was not an engineering one any longer—the untoward lifting of the bow, on June 22, had revealed that the mechanical preparations were correct and ample; but there was the reasonable fear that the nerves of the men might break. In the last analysis, success hinged upon the human equation.

On July 5, under favorable weather conditions, and with the salvage flotilla standing by to lend any possible aid, compressed air was sent down to the pontoons and into the several prearranged subdivisions of the *S-51* from the wrecking master's station on the bridge of the U. S. S. *Falcon*. By way of supplementing the 2 big Ingersoll-Rand compressors on the *Falcon*, that boat was linked with the *S-50*—a sistership of the *S-51*—by a 2½-inch fire hose which delivered air from the high-pressure bank or flasks of the submarine through a reducer set at 150 pounds. The air was stored in the *S-50* at a pressure of 2,300 pounds.

At 12.17 p. m., the *Falcon* started blowing the *S-51* by delivering compressed air to the stern of that vessel; and at 2.06, the stern broke the surface. The heavier bow did not come up until 3 o'clock. It had been estimated that the refloating would consume between 3 and 4 hours—as a matter of fact, it took just 2 hours and 43 minutes. When all 8 pontoons were up, the keel of the suspended submarine lay 32 feet below the surface; and the pontoons floated clear of the deck of the *S-51* so that



Manner in which each pair of pontoons was attached to the submarine by chain slings passing vertically through the hawse pipes of the pontoons and beneath the keel of the salvaged craft.

their movements in a seaway would not damage the underwater craft during the necessarily slow and anxious trip of 150 miles from the scene of the disaster to the haven of the dry dock in the Brooklyn Navy Yard. All the while, the *Falcon* followed at the tail of the procession with the multiple lengths of hose leading from her to the connections on the submarine and on each of the pontoons in readiness to furnish more compressed air instantly to insure the maintenance of the required measure of buoyancy.

It is a matter of history now that all went well until the submarine was in the East River and near the Brooklyn Navy Yard when, in order to avoid the possibility of colliding with two anchored pleasure craft, the flotilla swerved out of its course and tidal currents carried the submarine on Man-o'-War Reef. When high water served, the *S-51* was released and safely deposited within the dry dock during the evening of July 7. Thus was brought to a successful climax a salvage undertaking that stands alone because of the numerous difficulties overcome. Never before was compressed air at so high a pressure used to refloat a sunken craft; and never before was a greater measure of courage displayed in outwitting the sea.

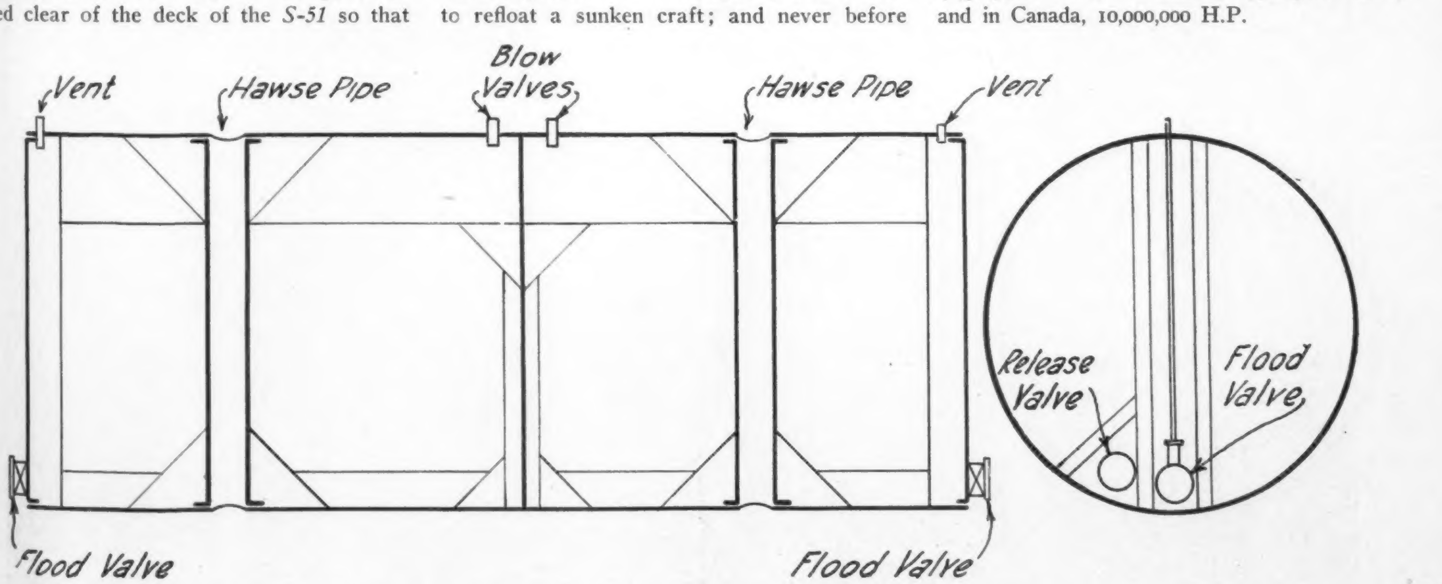
Note: This article is in accordance with the essential facts that were furnished the author by Lieutenant-Commander Edward Ellsberg, U. S. N.

NEW USE FOR CHROMIUM

FROM the *Washington Star* we learn that the life of electrolytic plates is measurably increased by the application of a layer of chromium. Experiments made at the Bureau of Engraving and Printing, Washington, D. C., have proved that by giving case-hardened-steel plates, for example, used in printing paper currency, a coating of chromium one-five-thousandth of an inch thick, the plates would last just twice as long as they would without this protecting coating.

This increased service is due to the notable hardness of chromium. Heretofore, its principal use has been in the manufacture of chromium steel for armor-piercing projectiles, safe plates, crushing machines, and other products calling for a metal of extreme hardness. But now that it is commercially practicable to do chromium plating, there is every reason to believe that that rare metal will find a wide field of service in the printing business, especially for the purpose of running off repeated editions.

The total mechanical horsepower produced and usefully employed in the United States, according to figures given out by Thomas T. Read, Assistant Secretary of the American Institute of Mining and Mechanical Engineers, exceeds 190,000,000, of which 111,000,000 is produced by coal, 67,000,000 by petroleum, and only 12,300,000 by falling water. Divided up among our population, the amount of power used per capita is equivalent to the physical power of 35 men working without mechanical appliances. In Great Britain there is developed today 45,000,000 H.P.; in Germany, 41,500,000 H.P.; in France, 17,800,000 H.P.; and in Canada, 10,000,000 H.P.



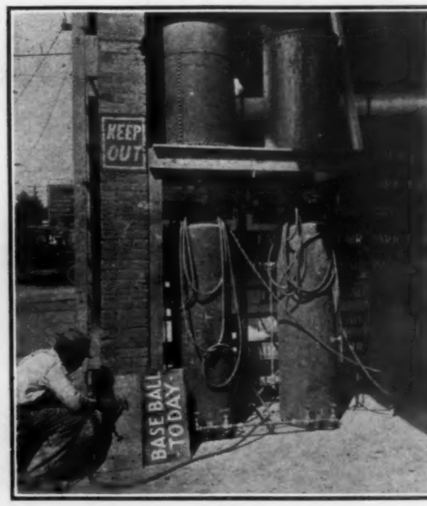
Longitudinal and cross sections showing the principal features of the pontoons used to refloat the "S-51." The two connections marked "blow valves" indicate where compressed air was discharged into the pontoon to expel water through the flood valves at the bottom of the pontoon. The two connections marked "vent" were opened when air was allowed to escape so that water could enter through the flood valves for the purpose of giving the pontoon sufficient dead weight to carry it to the sea bed alongside the submarine.

AIR-SPRAYED PAINT REMOVER

AS is well known, in order to do a satisfactory job, it is necessary to remove old paint from a surface before giving it a new coat. This work of paint removal has ofttimes proved laborious and has not infrequently added measurably to the cost of a contract. To speed up this preparatory work, as well as to save money, the former city chemist of Dallas, Tex., Dr. L. C. Moore, not only has produced a special chemical mixture which is said to remove paint effectually but he has also devised suitable equipment wherewith to apply the solution. The equipment is operated by compressed air, and is used by the Dallas Railway in removing old paint from the exteriors and the interiors of their cars.

As the accompanying picture shows, the outfit includes four large tanks—those on the left hand being used for mixing the paint remover and those on the right for mixing a solution employed in cleaning cars. The two bottom tanks are connected independently to a Pittsburgh heater—the fluids being applied hot. According to the *Electric Railway Journal,* 60 gallons of water and 18 pounds of Doctor Moore's preparation—known as "Mooreite"—are mixed in the uppermost of the left-hand tanks, and the liquid is permitted to flow into the container immediately beneath. Thence the solution is forced by compressed air through the coils of the heater, where it is raised to a temperature of about 175°F.

Attached to the outlet of the heater is a short length of hose provided with a suitable spray nozzle and thumb valve, which enables the operator to regulate the flow of the mixture. Usually, a small stream is directed at the surface to be treated until the paint becomes soft and falls off. With the paint disposed of, the surfaces of the car are thoroughly washed with clear water so as to neutralize any effect the chemical otherwise might have on the metal.



Courtesy Dallas Railway Company.
Compressed air is the motive power used in this apparatus to spray a chemical paint-removing mixture that is said to be effective and economical.

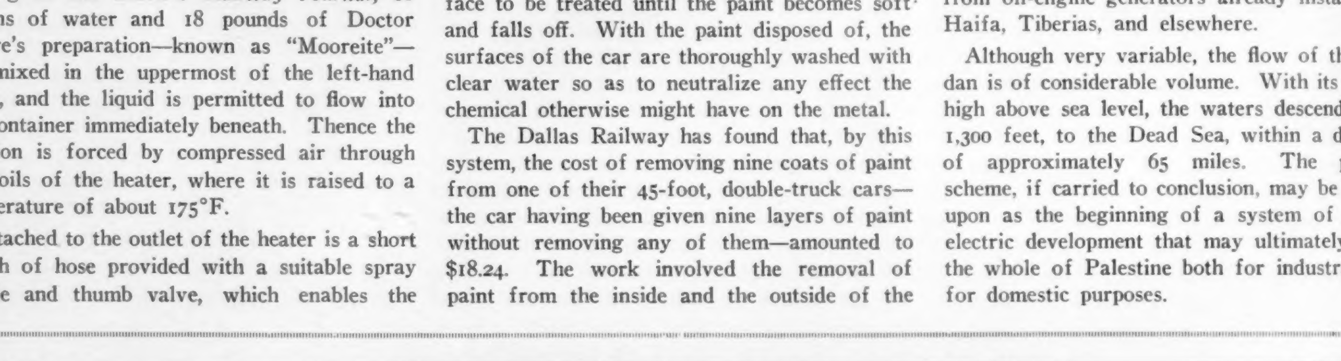
The Dallas Railway has found that, by this system, the cost of removing nine coats of paint from one of their 45-foot, double-truck cars—the car having been given nine layers of paint without removing any of them—amounted to $18.24. The work involved the removal of paint from the inside and the outside of the car, as well as from the wooden seats. By using another kind of paint remover on the metal surfaces and by employing the blowtorch to rid the wood of its coat of paint, the same job would have cost $33.80.

For the purpose of cleaning paintwork, 2½ pounds of "Westolite" is mixed with 60 gallons of water—the cycle of operations in the case of this part of the outfit being the same as that just described in connection with the paint remover. Formerly, the cleaning of a car, both inside and outside, with brush and soap cost $2.94. Now, by means of the air-operated equipment, the work takes less time and costs less than half—that is, $1.35.

ELECTRICITY FROM THE RIVER JORDAN

THE River Jordan, in Palestine, which stands unique in the matter of historical associations, is to add another chapter to its crowded record. Bernard Flexner, President of the Palestine Economic Corporation, has announced that a hydro-electric station is to be erected on its banks to supplement the power from oil-engine generators already installed at Haifa, Tiberias, and elsewhere.

Although very variable, the flow of the Jordan is of considerable volume. With its source high above sea level, the waters descend about 1,300 feet, to the Dead Sea, within a distance of approximately 65 miles. The present scheme, if carried to conclusion, may be looked upon as the beginning of a system of hydro-electric development that may ultimately serve the whole of Palestine both for industrial and for domestic purposes.



An exhibit at a fair recently held in Paris, France. This display of air-operated equipment attracted a good deal of attention among people interested in reducing manual labor and in speeding up operations in many fields of effort.

Oil-Electric Locomotive Makes Good

THE oil-electric locomotive is proving the claim made for it by its producers and engineering experts. This is the assertion made by the men in whose charge the actual operation of this type of locomotive has been placed by Eastern and Mid-western railroads which have recently purchased oil-electrics.

Oil-electric locomotive of the 60-ton type making ready to pull a loaded coal car up a ramp having a gradient of 25 per cent. In this way the coal car reaches the tipple.

The superintendent of one of those roads, which now has two of the 60-ton type in operation, speaks of them as "wonderful engines that will effect many economies." He finds the oil-electric equivalent to from 1½ to 2 steam locomotives for yard service, with a capacity to work 24 hours on a stretch, while the steam locomotive can work but 16 hours—being forced to retire to ash pits to have the clinkers cleaned out and the cinders removed. "Ash-pit work is the hardest labor on the railroad," says this official. "Steam locomotives have to be brought in and the fires raked at least every 16 hours. By doing away with this work, the oil-electric locomotive effects a tremendous saving in time and in money.

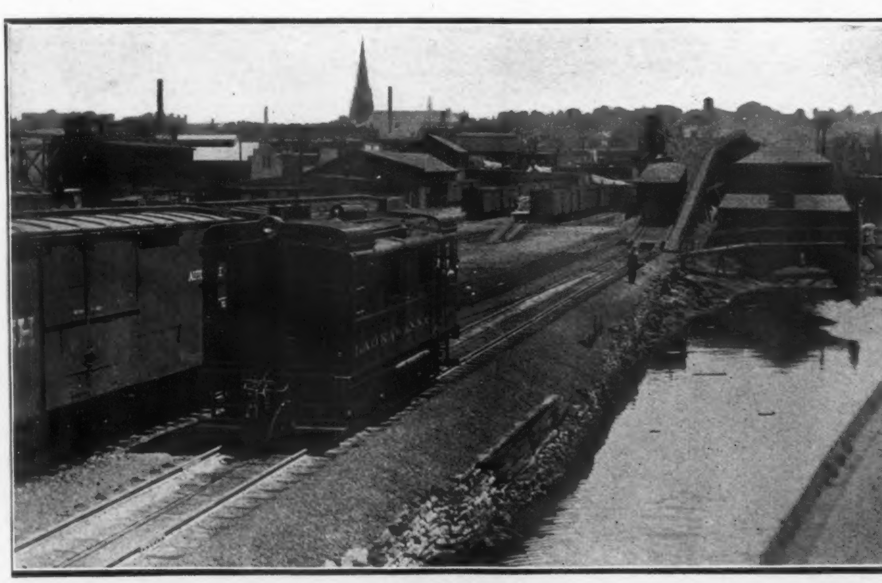
"Aside from this, there are savings in the cost of fuel that must make railroad executives think hard. The oil-electric has shown itself on our road to be a sturdy worker, and a marvel in every sense. It is bound to work a change in practical economy on our American railroads."

At the city yards of another railroad, even though an oil-electric locomotive has been employed there for but a few weeks, everybody—from the yardmaster to the engineer and the brakemen—is enthusiastic about its performances. It's much faster, they say, on the level in handling cars on and off the floats and in distributing them throughout the yard and is, therefore, capable of doing much more work.

The oil-electric is used for an interesting operation in this yard where there is a coal tipple, reached by a track of from 75 to 100 feet in length and with a grade close on to 25 per cent. Coal cars are drawn up this grade by the oil-electric by the aid of a heavy steel cable and a pulley. At this work, say the men in the yard, the oil-electric is much more effective than the steam locomotive. Formerly, with the steam engine, it was necessary to work up steam to full pressure before starting on the pull, and then, not infrequently, the engine would stop in its wheezing, and puffing, and snorting, and would have to let the coal car down the grade and start it up all over again. With the oil-electric engine there is an easy pull—denoting superior tractive effort; and it is possible to bring the coal car to a full stop at any point on the grade and then to start from that stop and complete the grade. Aside from this, it was pointed out that the oil-electric is steadier in its operation than the steam locomotive, there being no jerking in pulling the car up the ramp, such as is the case with the steam locomotive. This adds a further element of safety in favor of the oil-electric.

The yardmaster of another Eastern road declares that "the oil-electric is the greatest thing that has come to the railroads in years." He went on to say: "You must realize that we have had our oil-electric only a month, and we had to get used to it, but despite that handicap it is one week ahead of the record schedule made by a steam locomotive doing the same work in the same yard. We have had absolutely no trouble with it from the beginning: it is smokeless, easy to start, and possesses a tractive effort at starting that eclipses anything we have ever experienced with other forms of locomotives. My engineer is crazy about it to such an extent that he has gotten other engineers from other roads to come over and inspect it in operation."

The engineer on an oil-electric operated by another Eastern railroad said: "I had always run a steam locomotive before and didn't like the idea of running this new engine. The first two weeks I didn't enjoy it, but since then every day makes me like it more. The oil-electric is easier to handle; and you can see much better from the driving seat. It certainly is surprising all of us old hands by the work it is capable of doing."



Oil-electric locomotive pulling the loaded coal car up the steep ramp by means of a connecting steel cable.

By a striking but not astonishing coincidence, estimates made by executives of the four railroads in question are in agreement, giving for each oil-electric a saving in fuel and roundhouse expense of at least $10,000 a year. This means that if it were possible throughout the country to supplant the existing steam engines by oil-electrics, there could be effected the enormous saving of $700,000,000 a year on fuel and roundhouse expense alone. The four railroads are unanimous in the opinion that the oil-electric, having a capacity to work for 24 hours on a stretch, is

equivalent to from 1½ to 2 steam locomotives.

A mid-western railroad, which installed an oil-electric a few months ago, has found the performance of the locomotive so effective that it has ordered another one. Ever since it was put to work the locomotive has been in service 24 hours a day, with three 8-hour shifts. Two steam locomotives that formerly did the work taken up by the oil-electric have been withdrawn from switching service and are now in use elsewhere.

One of the officials of this railroad, in comparing the oil-electric with the steam locomotive, said: "The oil-electric gives 8 hours more service a day than the steam locomotive and is much more economical to operate. The substantial saving is in fuel: the average cost for fuel oil having been $6.62 a day as against $20.47 a day for a steam locomotive. On the basis of 300 days a year, the fuel bill for the oil-electric would be $1,986, as compared with $6,141 for steam-locomotive service.

"Projecting the figures over a year, including roundhouse expense and cost of lubrication, we now estimate oil-electric-locomotive operation to cost $13,200 and steam-locomotive operation $24,696."

An axle with the all-metal brake assembled on it. This type of brake is air operated and designed especially for heavy hauling control.

AIR BRAKES FOR MOTOR TRUCK TRAINS

By A. M. HOFFMANN

PUBLIC-safety laws are becoming more and more stringent. As a heavy moving load, if not perfectly controlled, is a menace to life and limb, most state laws now demand that street cars, railway trains, and certain types of common carriers be equipped with air-brake systems; and it is not unreasonable to suppose that before long the law will require that heavy trucks and trailers be provided with power brakes of some kind.

With the increasing use of vehicles of this sort, it is desirable that they should be under control at all times not only from the standpoint of safety but to assure the delivery of their loads in good condition, as well as to keep traffic moving freely. Then, too, the speedier transportation of goods from door to door means money in the pocket of the shipper and the consignee—statistics having proved that traffic delays, especially in congested cities, add millions of dollars annually to the cost of this service. There is another point that is of inestimable value, and that is confidence on the part of the driver. A driver that knows that he can count on his car to respond goes ahead with an assurance that makes for far faster as well as safer travel.

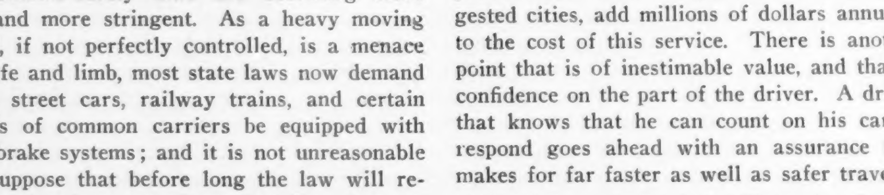
Whether or not the law will require that all heavy haulers be provided with air brakes, the advantages of such a system of control are now generally recognized; and the experience of one trailer maker, the Warner Manufacturing Company, has convinced him that, in order to insure efficient operation and perfect control, it is necessary to use power brakes for loads heavier than six tons. Therefore, all trailers and semi-trailers that have a carrying capacity greater than six tons are turned out by this company equipped with standard air brakes. According to the vice-president of that concern, Mr. L. P. Warner, "Our decision to use air brakes is based upon sound investigation and experiment. It has resulted from practical experience."

Furthermore, Mr. Warner says: "The most spectacular of our tests were made with trailers operated by the Western Maryland Dairy, of Baltimore, Md. The units weighed 40,000 pounds gross, and were tried out going down a 4 per cent. grade at 20 miles an hour. The results were conclusive. Under those circumstances, the trailers, fitted with air brakes, could be stopped after the air was applied within less than 20 feet. The results completely verified our previous belief.

"We recently sent out on the road a national demonstrator unit, consisting of a 4-ton automatic semi-trailer followed by a 4-ton semi-trailer equipped with a dolly. Eight of the ten wheels of the combination were fitted with air brakes: the four wheels of the tractor and the two rear wheels of each trailer. Traveling at 30 miles an hour, with capacity loads, the train could be stopped in a shorter distance than any following passenger car. In fact, we seldom dared to put the brakes on full force because, despite warning signs painted conspicuously on the back of the unit, autoists refused to believe that we could come to a halt so quickly, and frequently ran into the train when it made a dead stop.

"In order to operate satisfactorily with the high pressure exerted by air, the brake construction must, of course, be sturdy. To that end, we use a mild steel liner for both the shoe and the drum. And right here two economies should be noted. In the first place, such a brake lining will last two or three times as long as one of fabric. Going down grade, if sufficient pressure is applied long enough to control the unit, a fabric quickly burns out. An all-metal brake, on the other hand, can be run even when red-hot down the longest hill without injury. In the second place, when the metal liner has passed its stage of usefulness, a new one can be inserted in its place much quicker than a fabric lining.

"The efficiency of the air brake depends, besides, on its construction. The ordinary fabric brake is hinged on one side, and all the action comes from a single cam opposite this hinge. Consequently, from 60 to 70 per cent of the braking surface is lost. We use a double cam so that the segments expand from a diameter line in both directions. Therefore, every inch of the available surface is utilized, thus exerting greater power."



Combination tractor and semi-trailer. Air-operated brakes are effective on all six wheels of the unit.

Novel Emergency Plant Used by Gas Company

By THE STAFF

THE increasing demand for gas in the past few years, both for domestic and industrial purposes, has induced the Rochester Gas & Electric Corporation, of Rochester, N. Y., to greatly expand its facilities. Along with this expansion has come the realization that customers should be protected as far as practicable from the inconveniences—not to mention hazards — attending any interruption in service brought about through a failure of primary power in the gas plant. Let us make this clear.

Courtesy, Rochester Gas & Electric Corporation.
Novel type of automatic high-pressure gas storage tanks that constitute a reserve in case of interruption to power service. 1 and 3, Pop valves; 2, Weatherproof manhole; 4, Cut-off valve; 5, Swivel joint for expansion.

Take, for example, the 6-inch high-pressure main that distributes gas from the holder at Brighton to consumers—including several large industrial establishments—in Pittsford, Fairport, Penfield, East Rochester, and neighboring communities. This line is 12 miles long; and in order to furnish the customers with gas at a suitable pressure, it is necessary that the gas in the holder be maintained at a pressure of 30 pounds to the square inch. For this purpose—that is, to compress the gas—there is used a large duplex, electrically driven I-R compressor. The problem that faced the company was how to keep up a steady flow of gas, at the required pressure, in the mains in the event the current should give out—something that is liable to happen at any time even in the most efficiently operated power plants.

As conditions at the Brighton holder did not favor an all-year-round spare drive by either gas or steam engine — the cost of operating such an installation being considered too high—the management decided to try something entirely new. Three automatic high-pressure storage tanks were built as stand-bys—that is, they were so designed that they would automatically feed gas, at the desired pressure, into the distributing main the moment the electric current failed. Needless to remark, much time was spent in devising and in constructing this novel storage system used by the Rochester Gas & Electric Corporation.

From *Gas Age-Record* we learn that the tanks, shown in the accompanying illustration, are made of $1^1/_{16}$-inch steel boiler plate held together by $1\frac{1}{4}$-inch rivets. Each tank has a diameter of 10 feet, is 62 feet 8 inches long, and has a capacity of 150,000 cubic feet when the contained gas is at a pressure of 150 pounds to the square inch. As a safeguard against leakage, the manholes are fitted with gasproof gaskets; each tank has two 2-inch pop valves as a protection against expansion; and means are provided to draw off the condensate. All piping, fittings, and valves are of extra-heavy material to withstand expansion due to a sudden rise in temperature.

Before reaching the distributing main, the gas from the tanks is first passed by way of a heavy 4-inch pipe through a reducing valve and an automatic electric valve. There are two electric valves in the system—one automatically opening and the other automatically closing when the electric power fails. In principle, they are balanced-spring disk valves that are acted upon by counterweights which, in turn, are released by solenoids when the power is cut off for one reason or another. An automatic siren, functioning in connection with these valves, warns the operator when the pressure on the gas in the holder is no longer being maintained.

About two months after the storage tanks had been put in commission, there occurred a breakdown in the electric system that lasted for ten minutes — the high-pressure tanks immediately taking up the load dropped by the holder and supplying gas at the required pressure to the distributing main the while. The recharging of the tanks is effected by means of a small air compressor.

A year's service has convinced the management of the Rochester Gas & Electric Corporation that this stand-by system can confidently be counted upon to fill in the gap and to furnish gas under the conditions described; and from the standpoint of the consumer, especially if he be a manufacturer, the protection offered against even a short suspension of operations is of much value.

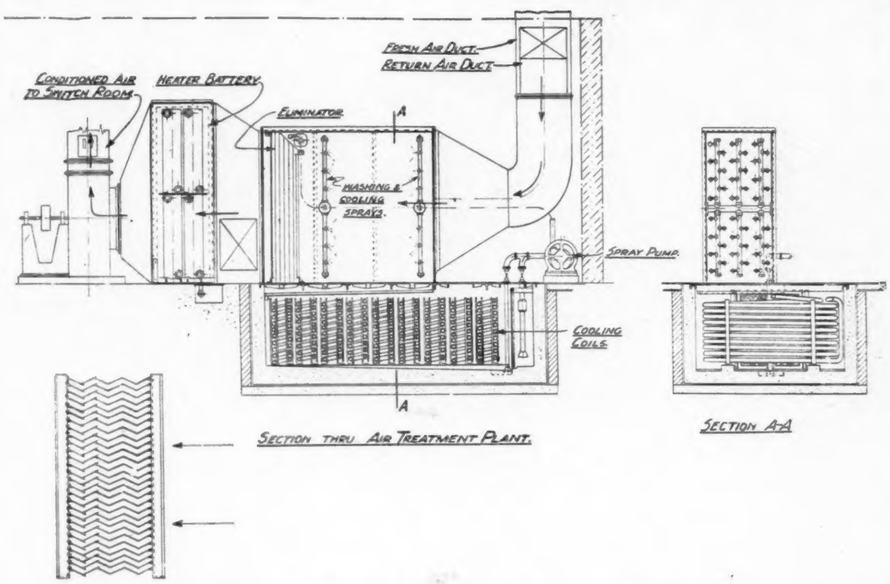
An electrically driven compressor of this type maintains the gas at a pressure of 30 pounds for distribution to customers along a 12-mile line.

AIR-DRIVEN RIVET HAMMERS HAVE MANIFOLD FIELDS OF USEFULNESS

Fig. 1—Riveting up a rattler for use in a railway repair shop.
Fig. 2—Assembling the bottom plates of a large oil tank with cold-driven rivets.
Fig. 3—Driving rivets in a locomotive fire box.
Fig. 4—The rivet hammer has much to do in an up-to-date motor-car plant.
Fig. 5—Riveting a bridge member in a fabricating shop.

Refrigeration in Conditioning Air

IN substance, this was the title of a paper read some months ago by A. Lewis before the Victorian Institute of Refrigeration. Mr. Lewis is Chief Mechanical Engineer, Department of Works and Railways, Commonwealth of Australia. The paper dealt chiefly with conditions in Australian telephone exchanges; and was the outcome of exhaustive research and testing carried out by Mr. Lewis and his staff. At the time of presenting his paper, air-conditioning plants had been installed in substantially twenty telephone exchanges and public buildings in Australia, and plans for a number of other kindred plants were then in course of preparation. The paper is authoritative and comprehensive; but owing to the limited space now at our disposal it is possible for us only to reprint extracts. As Mr. Lewis states his case:



Air-treating plant installed in the Collingwood Automatic Telephone Exchange.

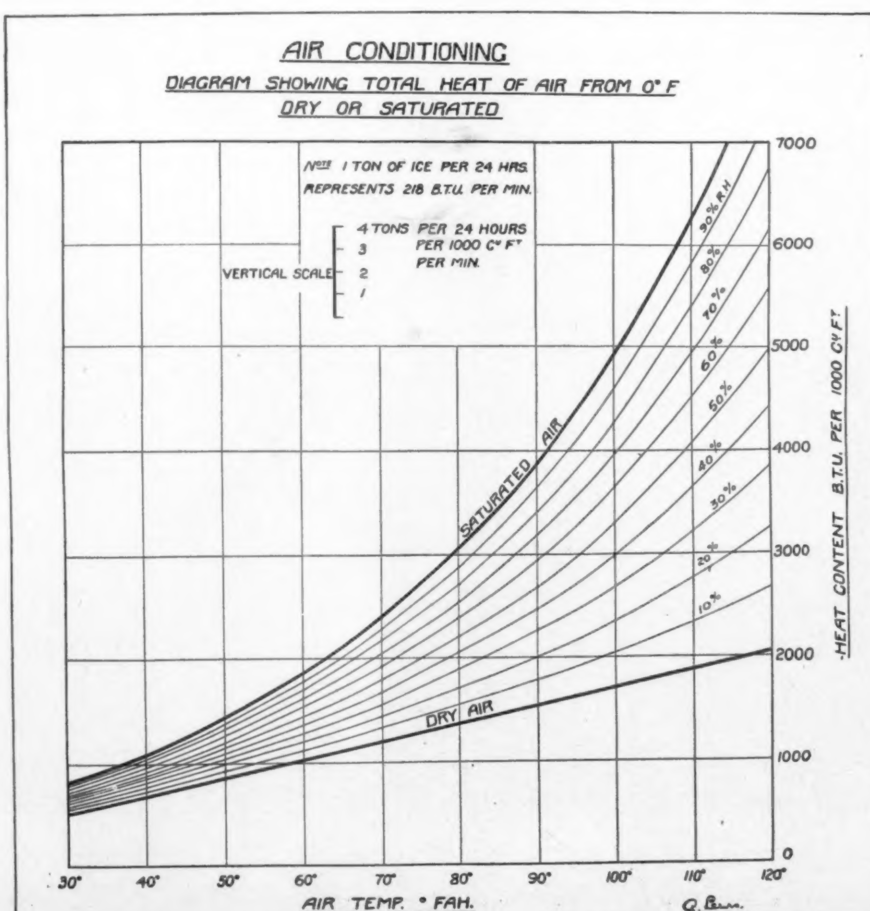
"The necessity for refrigeration in air-treatment equipment involving limits of humidity and temperature is receiving wide recognition. For many years, air cooling by the use of melting ice has been practiced, and to this day installations are being equipped with provision for ice racks through which air is passed for direct cooling, or with shelves or tanks through which spray water is passed for indirect air cooling.

"The extent to which refrigeration is necessary depends upon the air conditions required relative to the external local weather conditions, with particular regard to the structural materials and to the thermal effects of the manufacturing processes carried out in the treated rooms.

"In Melbourne we are faced with a temperature range of from 27° F. to 111° F.; with humidity ranging between 20 per cent. and saturation; and with tap water approximating 72° F. in summer and 45° F. to 50° F. in winter. With no prospect of obtaining colder water from underground sources, thus we can only look for air cooling by water evaporation at limited periods of high temperatures and low humidities.

"For automatic-telephone exchanges, it is stipulated that the humidity should not exceed 70 per cent., and that the air should be clean. With a view to economy in installation and operating costs, attempts were made to obtain these conditions by means of air washing and heating; and the buildings were constructed to minimize the risk of untreated dust-laden air entering the switch room.

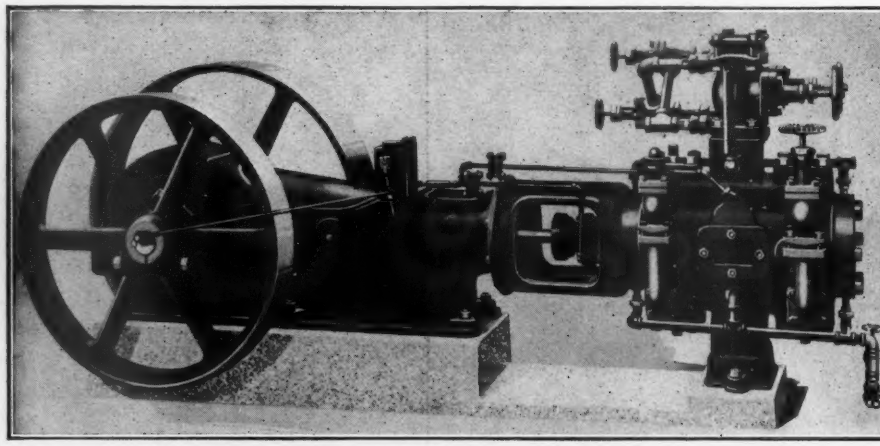
"In staffing an automatic exchange under normal working conditions, some 8,000 cubic feet of air space is available for each employee, while at installation periods the space per occupant may drop as low as 800 cubic feet for short periods. In investigating the ventilating requirements, the normal space per occupant was considered large enough to warrant not more than one change of air per hour; and this limited provision was made for the first exchanges, which were equipped with a ventilating plant including an air washer. Heating was effected by direct hot-water radiation, and provision was also made for vacuum cleaning and for compressed-air dusting. . . .



"From the experience gained in the plants designed and in operation, a number of improvements involving minor alterations have been designed and are being put into practice as opportunity offers. Most of the buildings treated are single story, and are constructed of brick with a reinforced-concrete roof shielded from the rays by a hipped roof of iron or tiles—the outer concrete surface being exposed to shade temperatures not exceeding 110° F., compared with 160° F., if subjected to direct sun's rays. Under the worst conditions, a large volume of air is discharged to atmosphere at

temperatures rarely exceeding 82° F.; and this air is now being diverted through the roof space and is expected to maintain the outer surface of the concrete ceiling at a temperature not exceeding 90° F., with considerable saving in refrigeration.

"In multi-story buildings, the greatest thermal loss is through window glazing, and practice here will be to provide double sashes to windows arranged with regulatable outlets at the top of the inside glazing and similar openings at the bottom of the outer sash. The expenditure will be amply repaid, especially in lower temperature process rooms. . . ."



Type of ammonia compressor widely employed in Australia for air-conditioning service.

In regard to the different kinds of refrigerating machines, Mr. Lewis had this to say: "A wide range of types of machines is now in use under comparative conditions of duty, including low-speed horizontal, with poppet valves and with plate valves; high-speed horizontal with featherweight valves; high-speed vertical, with both plate and poppet valves; and low-speed vertical with poppet valves; and there is considerable difference in the operating characteristics of the different types. Tests and observations are now in progress. As far as these tests have gone, it would appear that there is considerable room for improvement in design. . . .

"Air treatment for process rooms, including such as confectionery manufacture, is being developed along two lines: the first and earlier practice being to deliver the conditioned air into the vats or process vessels—the escape from such vessels being used to improve the general ventilation of the process rooms; and the second and later practice being to provide adequate general ventilation to the whole room.

"In the former practice, the air leaving the process vessel is usually charged with essential vapors, objectionable as regards human occupancy; and health regulations throughout the world are demanding that such vapors be withdrawn from as near as possible the point at which they are generated, and treated before discharge to atmosphere. In rooms designed with due regard for thermal effect, the general ventilation offers many advantages, not the least being that a higher spray temperature is permissible in the conditioner; and staff comfort and welfare are now also regarded as necessary for economic output."

SPRAY PAINTING DRUMS EFFECTS SAVINGS

SPRAY painting is finding steadily increasing favor; and the following interesting item, which recently appeared in the *National Petroleum News*, is more evidence of the superiority of this method of applying paint.

Spray painting of lubricating-oil drums, besides doing a better job than the brush method, has been found less expensive by Jack Nourse, of the Nourse Oil Company. Where he formerly kept three men busy, one man now does the work and uses only about half the paint in going over the same number of barrels. The Nourse Oil Company has been using this method for about eight months.

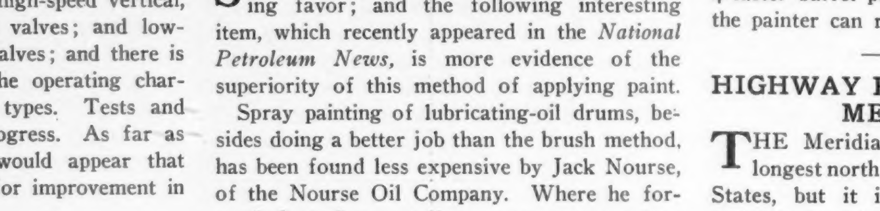
A 1-gun air spray, costing about $100, has been found sufficient for the work at this plant, which handles a far larger number of barrels than the average jobbing plant. Various colors are employed by simply blowing one color out of the tube and spray before letting another feed into the line. Mr. Nourse is of the opinion that the paint is spread more uniformly on the barrels with the spray than could be done with brushes. He believes that the saving in brushes is a considerable item in favor of the air spray, because brushes wear out quickly on steel drums.

About 35 pounds pressure is needed to work the paint spray, and this air is furnished by the compressor at the plant. So that the barrels can be turned more easily while being painted, Mr. Nourse has rigged up a homemade turntable. This turntable consists of a 4-caster barrel platform, on a fixed axis, that the painter can revolve with his foot.

HIGHWAY FROM WINNIPEG TO MEXICO CITY

THE Meridian Highway is not only the longest north-and-south road in the United States, but it is an international highway maintained under three flags. Beginning at Winnipeg, Canada, it follows the 98th meridian almost due south through Manitoba, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas, coming to an end at Mexico City after covering a distance of 3,100 miles. Already, the Meridian Highway can boast more miles of hard surface than any other north-and-south road between the Mississippi River and California; and this hard surface is being rapidly extended throughout its entire length.

Appreciating the benefits to be derived from such a through roadway, the Mexican government has recently appropriated funds to start the grading of the first section of the 1,200-mile stretch from Laredo, on the border, to Mexico City. Funds for the work are being raised by a tax on tobacco and gasoline.



These air lifts furnish water to the Jorge Street Cotton Mill in Sao Paulo, Brazil. The well at the right is 663 feet deep while the well at the left is 374 feet deep. In each well the casing is of 7-inch pipe, and the discharge is of 4-inch pipe—the air line being ¾ inch in diameter. The combined output of the wells is 10,303 gallons an hour. Operating air is furnished by an "ER-2" compressor; and the wells were drilled by J. Corner, contractor and engineer.

Why Machine-Made Drill-Steel Bits Are Superior to Hand-Made Bits

By D. E. DUNN and E. H. PAULL.

ANYONE at all familiar with rock drilling in mines and quarries, on roadbuilding projects, or on any form of rock-excavation work will grant without question the claim that machine-made bits are far superior to hand-made bits in the matter of drilling speed. Increased drilling speed is but one of several advantages that can be urged in behalf of machine-worked drill steels. The thing to be considered is overall plant efficiency and economy.

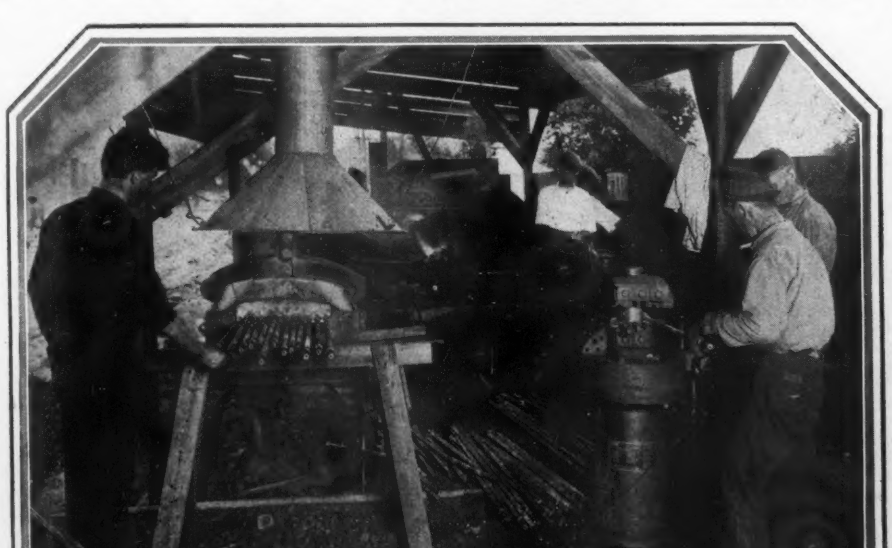
Putting in a drill hole is only the first of a series of interdependent operations. After the hole is drilled and the rock blasted, the broken rock must be removed from the immediate drilling face; and, next, it must be hauled, hoisted, and transported to its ultimate destination. These operations are as important as the drilling operation, yet they are all dependent upon the latter. That is why it is so important that the drilling round be put in on schedule time. If it is not, various delays will occur that will greatly increase production costs.

In this particular case, a development company has found it worth while to buy a "Leyner" sharpener to take care of the steels of a single "Jackhamer." The bits are so much better when machine made that they have increased the footage drilled by quite 50 per cent.

For the sake of argument, let us assume that it is possible to make a bit as well by hand as by machine. Even so, there is a time element which must be considered. Observations at hundreds of sharpening shops in various parts of the world have definitely proved that one man with a drill-steel sharpener can form or sharpen from three to ten times as many perfect bits as two men sharpening by hand. When all factors, such as interest on investment, depreciation of machinery, operating cost, and quantity of work are taken into consideration, it will be found that it costs about one-third as much to make a bit by machine as it does by hand.

There are several reasons why a machine-made bit will drill faster than a hand-made bit. The cutting edge of the machine-made bit is sharp and concentric. The material back of it is dense, having been compacted by hundreds of powerful hammer blows. The angle, of which the cutting edge is the apex, is correctly made so as to give the proper chipping blow. The clearance spaces between the wings of a machine-made bit are sufficiently wide to give ample room for rock cuttings to pass; and, at the same time, the wings are heavy enough to stand up under severe work. The wearing surfaces forged on the sides of the wings permit the drill to be used for a maximum time before losing its gage and having to be removed from the hole and resharpened. The sharpener-made bit is symmetrical. Because of this there is much less likelihood of holes "rifling." The machine-made bit will drill a smooth, round hole. This is not always true of hand-made bits. All the foregoing reasons are important, but the principal reason for the greater drilling speed of a machine-made bit is that it does not have to cut so much rock.

In practice, it is next to impossible to gage hand-made bits within a tolerance of ⅛ inch. Sharpener-made bits, on the other hand, can be gaged regularly to 1/16 inch of the prescribed dimensions; and, with few exceptions, a variation of 1/16 inch in diameter in succeeding bits is quite satisfactory. Small as the difference seems between a variation of 1/16 inch and ⅛ inch, still this difference in diameter, when drilling a 10-foot hole, means that the succeeding bits of the larger diameter must cut through just so much more rock in effecting the desired penetration. A fair estimate would put the excess rock drilled at 50 per cent. in the case of hand-made bits. Therefore, it is easy to understand why the machine-made bit will do its work faster and cost less in power consumption and in wear and tear on the drill—not to mention lightening the labor of the drill runner.



The "Leyner" sharpener and an up-to-date coke furnace have made this blacksmith shop equal to the work imposed upon it in keeping steels for numerous rock drills fit for their tasks.

Another advantage of the machine-made bit is that it permits the drill operator to do productive work during a much longer part of a working shift. Because of the avoidance of "rifled" holes, and because of the ample passage for cuttings between the wings and the bit, the steel is not so likely to stick in the hole and to force the operator to lose valuable time in trying to loosen it. This is a common cause of lost time in flat-hole and down-hole work. When a steel is sharp, it cuts the rock: when a steel is dull, it strikes the rock an ineffectual blow. The energy of this blow, which is transmitted through the drill steel, sometimes breaks the steel or even the

rock drill, itself. This breakage, aside from the cost of the parts and the cost of making repairs, is expensive, in that the miner may be idle and unproductive when his drill is out of commission. A reduction in the cost of repairs will be noticeable when using sharpener-made bits instead of hand-made bits.

All these advantages will result in a much lower cost per foot of hole drilled. Figures on large rock contracts show that the actual cost per foot of hole drilled with sharpener-made bits is slightly over half the cost per foot of hole drilled when hand-made bits are used. Again, a great saving is effected because of the reduction in the number of drill steels needed to do a given amount of work. Inasmuch as a sharpener-made steel retains its cutting edge and gage much longer, it is possible to get nearly twice as much footage with such a steel as with a hand-made bit. In case the steel should break, it will, of course, be necessary to upset the steel and to make an entirely new bit. When this work is done by hand, the operation takes about six times as long as it would to put a new edge on an old but unbroken bit. But when the work is done by machine, upsetting the broken steel and forming a new bit take only twice as long as it would to resharpen a worn but unbroken bit.

Emphasis should be placed always on seeing to it that the entire drill steel is in proper condition. That is to say, the shank is just as important as the bit, and this fact should never be lost sight of, no matter whether the steel is made up by hand or by machine. Shanks made on a sharpener are true in shape and in size. Therefore, they utilize the maximum power of the drill. Shanks made by hand may vary greatly in these particulars. If the shanks are even a little too long the piston of the drill cannot travel its full length and, accordingly, cannot develop its full power before hitting the steel. On the other hand, if the shank is too short, much of the power of the piston's blow will be absorbed by the fronthead and the springs instead of being delivered to the drill steel.

In short, good drill steels, with properly made bits and shanks, will contribute much to better overall plant operation. The drills will give maximum service; the holes will be drilled faster; and the blasting, mucking, hoisting, and other work will be carried out on schedule time while the efficiency of the entire plant will be increased proportionately.

NEW REVOLVING SHOVEL

A 3-yard revolving shovel that has recently been put on the market by the Bucyrus Company, of South Milwaukee, Wisc., has been designed especially for the contractor and the general user of excavating machinery. It is said to be a departure in shovels of this kind in that it is built along entirely new lines.

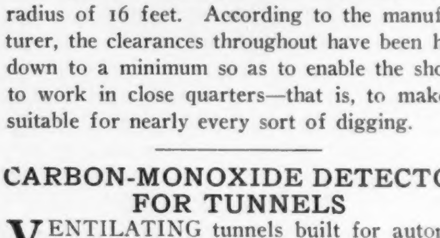
Briefly, the machine combines the advantages of the small revolving shovel and those of the railroad-type of shovel—therefore having a working range considerably greater than either. To be explicit, it has the speed of action, the big dipper capacity, the ruggedness, and the power of the railroad-type shovel as well as the mobility, the full revolving swing, and the maneuvering capacity of the small revolving shovel.

This revolving shovel has been designed for contractors and users generally of excavating machinery. The builders consider the shovel a distinct advance.

The boom of the new shovel has a length of only 29 feet 6 inches, and the rear end has a radius of 16 feet. According to the manufacturer, the clearances throughout have been held down to a minimum so as to enable the shovel to work in close quarters—that is, to make it suitable for nearly every sort of digging.

CARBON-MONOXIDE DETECTOR FOR TUNNELS

VENTILATING tunnels built for automotive traffic has emphasized the need of keeping a careful watch upon the presence of noxious fumes exhausted by the gasoline-driven conveyances. The worst of the noxious fumes likely to foul the atmosphere in tunnels of this sort is carbon monoxide, commonly termed CO, produced by the incomplete combustion of the liquid fuel burned in the motors. This problem has been the subject of much research on the part of the United States Bureau of Mines in an effort to safeguard persons traveling to and fro through the Liberty Tunnels, in Pittsburgh, and to protect similarly the many thousands of persons that will use the twin Holland Tunnels that underrun the Hudson River.



© Photo United States Bureau of Mines.
Monoxide recorder, devised by chemists of the United States Bureau of Mines, which will be used to keep check on the air in the twin tubes of the Holland Vehicular Tunnel under the Hudson River.

It has been determined that a person can breathe for an hour, without noticeable effect, a mixture of 4 parts of carbon monoxide in 10,000 parts of air; and the researchers sought to devise an automatic apparatus that would record so weak a mixture of air and CO and indicate in some suitable fashion when the safe limit was reached. The difficulty lay in discovering reliable media that would be sensitive to the presence of so small a percentage of the harmful gas. A successful equipment has been produced which depends primarily upon the use of a catalyst that will induce the oxidation of CO in the presence of air at ordinary temperatures—the heat caused by this oxidation being sufficient to affect a thermoelectric couple. The catalyst that meets this exacting requirement is a specially prepared mixture of manganese dioxide and copper oxide. It is known as hopcalite, and is used in a granular form. The catalyst was first employed in gas-mask canisters during the World War for the purpose of neutralizing or destroying CO.

Hopcalite, or other catalyzers of oxidation, can act on many combustible gases when those gases are mixed with air or oxygen either at atmospheric temperatures or at higher temperatures. Therefore, apparatus such as have been described recently by the Bureau of Mines, in Technical Paper 355, might have a wide field of useful service independently of that of indicating the approach to a dangerous state of the air in vehicular tunnels.

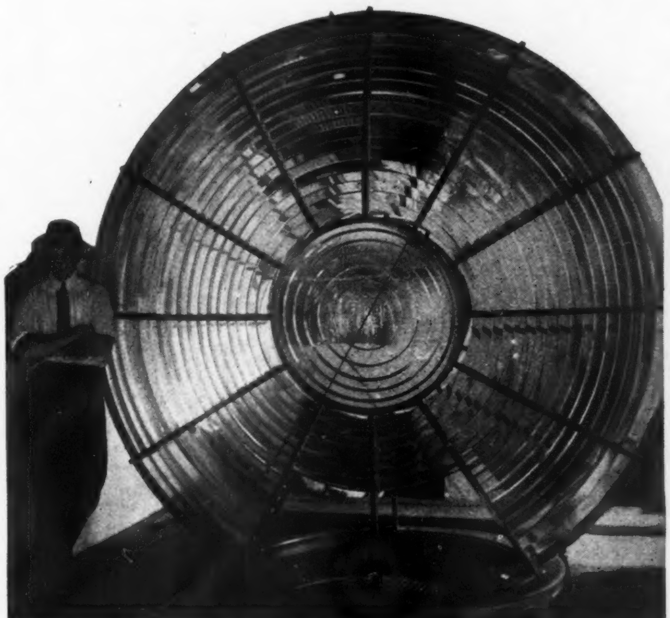
How America Safeguards the Navigator

In Building and in Repairing Maritime Aids Compressed Air Performs Many Services

By F. A. COLLINS

A GREAT transatlantic liner was approaching New York City in thick weather, after dark, at a pace of nearly 25 knots an hour. She had safely passed Nantucket lightship, and was speeding parallel with Long Island while keeping well out to sea. The string of lighthouses placed along the shore for the guidance of shipping proved of little assistance, because the curtain of fog blotted out the most powerful of their rays. Meanwhile, the officers in the wheelhouse laid the ship's course towards the entrance of New York harbor with confidence and with mathematical precision.

A comparatively few years ago, a vessel inward bound in such weather would have hesitated to proceed and would have slowed down or even anchored until daylight or until better atmospheric conditions would reveal her course. The great modern liner, carrying a population equal to that of a small town, runs on a regular schedule like a railroad train. A day's delay would mean great inconvenience to hundreds of passengers, not to mention the holding up of mail matter and cargo. Few of the passengers probably realize what has been done to safeguard shipping and the lives of those "that go down to the sea in ships."

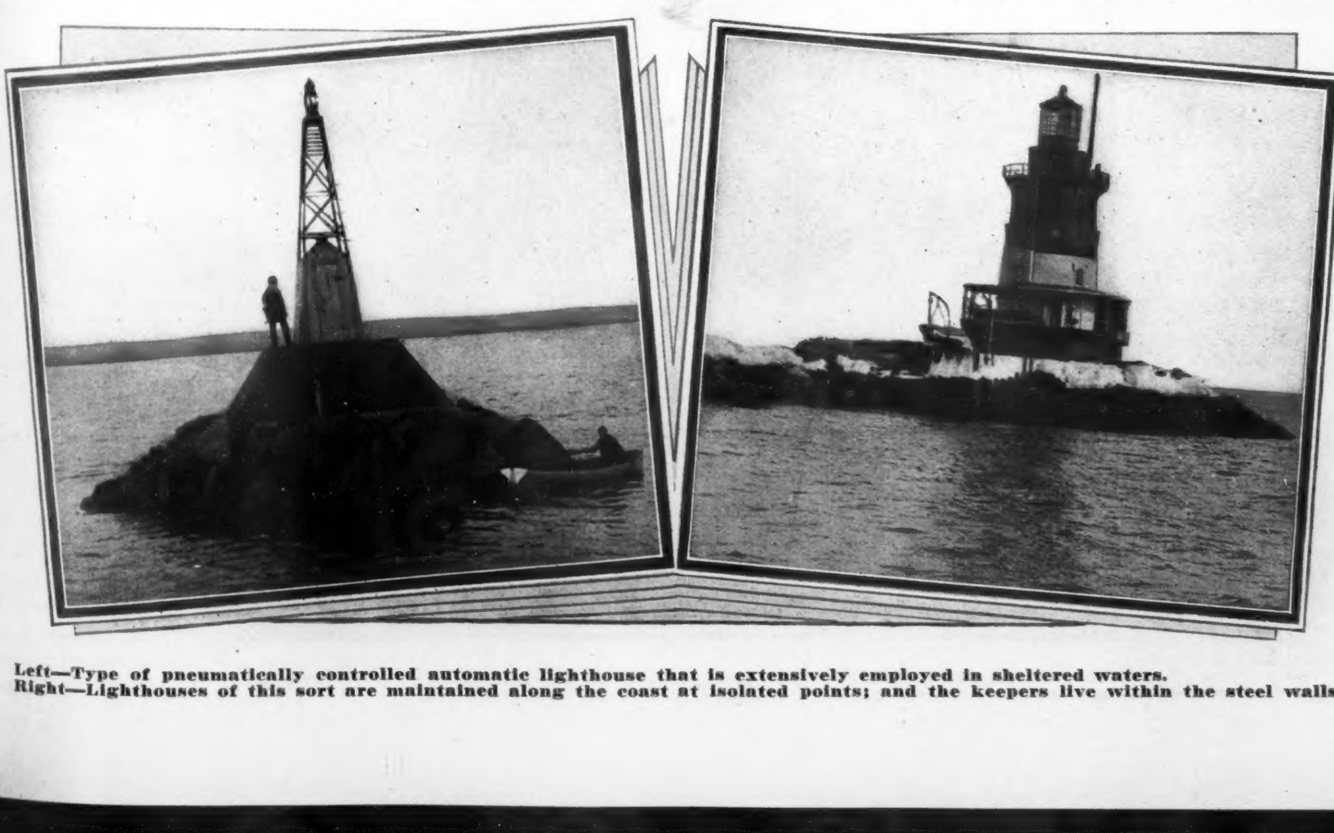


A monster lens in a lighthouse that projects its guiding beams seaward for many miles.

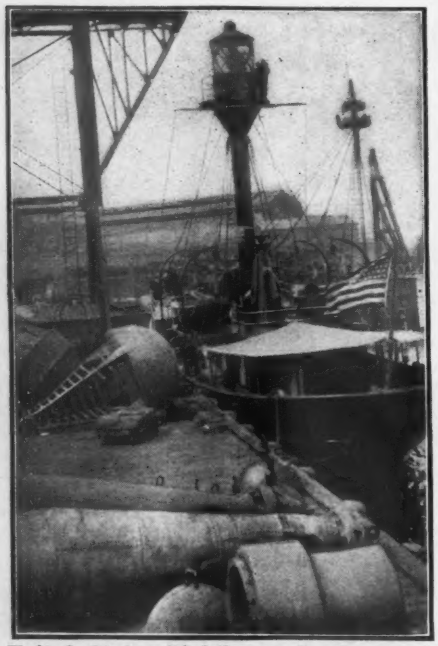
An entirely new system of lighting the coastal waters of the United States has been adopted in the past few years. The problem is an extremely complicated one. It is not generally known that the Third Division of the United States Lighthouse Service, which includes New York harbor, controls more lighthouses and navigational markers of various kinds than are to be found around the British Isles. In fact, the approaches to New York harbor from the north and the south along the coast and from the open sea undoubtedly are provided with the world's most complete system of day and night signals, which will serve admirably to illustrate the progress that has been made in this country in protecting shipping nearing our shores.

Today, the old type of lighthouse, with its picturesque stone tower, does little of the actual work of guiding shipping. Perhaps in a few years from now its beacon may be extinguished. It is rapidly being replaced by innumerable smaller lights that are distributed at frequent intervals along our shores and some distance seaward along our steamship channels or lanes. These signals are supplimented by radio-compass stations—the radio compass having proved itself one of the greatest aids to navigation since the invention of the mariner's compass. Could a seafarer of a century ago return, he would probably consider our new system of maritime signals the work of magic.

American ingenuity has played a large part in improving the navigational aids used in this country; and this advance in the art is in no small measure due to modern labor- and time-saving machinery. For example, in the shops, where the different mechanisms are built and repaired, and aboard repair ships at sea, com-



Left—Type of pneumatically controlled automatic lighthouse that is extensively employed in sheltered waters.
Right—Lighthouses of this sort are maintained along the coast at isolated points; and the keepers live within the steel walls.



United States Lighthouse Service station where buoys and lightships are repaired.

pressed air has rendered invaluable service. This convenient form of energy is commonly used when reconditioning lights offshore, where steam or electricity cannot be conveniently employed. This offshore work is often carried on under very unusual and picturesque conditions.

The thousands of lighthouses, illuminated buoys, markers, and other navigational aids in commission must be regularly visited by lighthouse tenders. These tenders must be of sturdy build, as they are called upon to patrol our entire seaboard of thousands of miles the year round and in all kinds of weather. Besides carrying supplies to isolated stations, they also form the bases from which damaged lights, either ashore or afloat, are repaired or replaced, and must, therefore, be something in the nature of floating machine shops.

When an illuminated buoy, for example, is damaged by high seas, as not infrequently happens, it must be quickly repaired. Obviously, should its light be extinguished, a mariner might go astray. Instead of wasting valuable time in towing the crippled buoy to the nearest port or lighthouse station, the floating machine shop proceeds to the scene of the accident and does the required work right on the spot as quickly and as efficiently as it could be done on land. If necessary, powerful cranes can lift the floating beacon bodily from the sea on to the deck, where its steel shell can then be conveniently drilled, riveted, and calked, as conditions may call for. Ofttimes these operations are carried on during a high sea, which tosses the tender about like the proverbial cork. Each tender has a compressor aboard that furnishes the air to drive the various pneumatic tools now used in this maintenance service. Needless to remark, air-driven tools have done much to facilitate this work of repair and have lessened proportionately the time a light or other signal is out of commission. One of the advantages of compressed air is that it performs equally well on the heaving deck of a small craft at sea as it does in a shop ashore.

It will come as a surprise to the layman to learn that illuminated buoys will burn for many months—in some cases for a period of two years—without replenishing their fuel supply; and the average light of this sort will burn for from two to six months without attention of any kind. They are made in several sizes that range in weight from 2,800 to 34,500 pounds. Some of them are provided with sound-producing devices, such as a whistle or a bell, in addition to the light. Gas is the lighting medium used, and this illuminating gas is stored at high pressure in special tanks placed inside the beacon.

In the past, as previously mentioned, it was the practice to spend hundreds of thousands of

The kind of range light now placed in protected waters to guide the mariner. The supports for this light were driven into the water bed with compressed air.

dollars to erect at various danger points along the coast great stone towers to hold aloft powerful lights. Today, hundreds of automatic illuminated buoys take the place of one of these big lights, and do the work much more satisfactorily. The value of innumerable small lights can be better appreciated by citing a single example—using Barnegat Light, situated on the New Jersey coast, to make the comparison. Ocean liners are obliged to keep about five miles offshore at this point to avoid dangerous shoals; and yet, in thick weather, the powerful light at Barnegat is not visible so far out at sea. By placing strings of automatic lights five miles out to mark the ship lane, vessels can proceed safely.

The United States Lighthouse Service at present maintains about 8,000 buoys of all types along its seaboards and inland waterways. No country in the world possesses anything like this number of aids to navigation. They are used for the most part to indicate shoals or other danger points, to mark approaches to channels or the channels, themselves, and to outline the boundaries of anchor-

A damaged bell buoy that has been returned to a repair station for overhauling and refitting. It was probably smashed by a craft blinded by fog.

ages, etc. These buoys come in various forms, and are usually moored by chain to cast-iron sinkers. As the wear and tear upon these exposed signals is naturally very great, it can readily be understood that an immense amount of repair work is necessary to keep them in good condition.

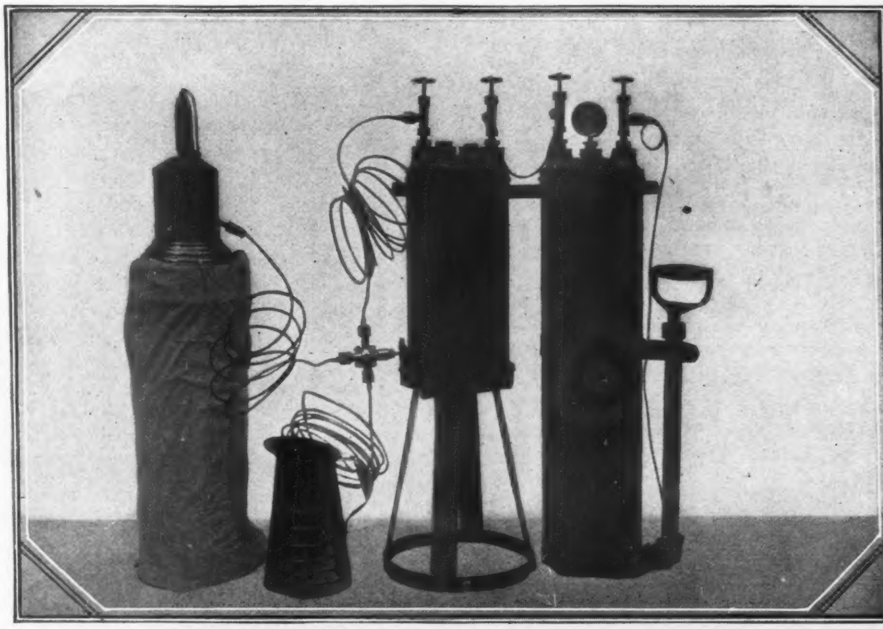
The commonest form of warning light is the post light, which stands guard at the channels of inland waters and guides our immense tide of inland shipping. At every turn, these lights flash their warning signals to keep the navigator from going astray. Unattended lights of this description, like the automatic floating buoys, generally burn gas under pressure, and are recharged at intervals of several months.

The engineers of the service have developed a simple steel tower or support for the post light, which is a great improvement over other types of beacons formerly used. As a matter of fact, these lights have been so standardized that they can be ordered by number and delivered ready for erection at any desired point without the loss of much time. In view of the service rendered, it can be appreciated that any saving in time in putting up a new light in place of a damaged one is of vital importance. The newest type of tower consists of four steel pipes, which are planted deep in the bed of a river, or other waterway, and are strongly braced.

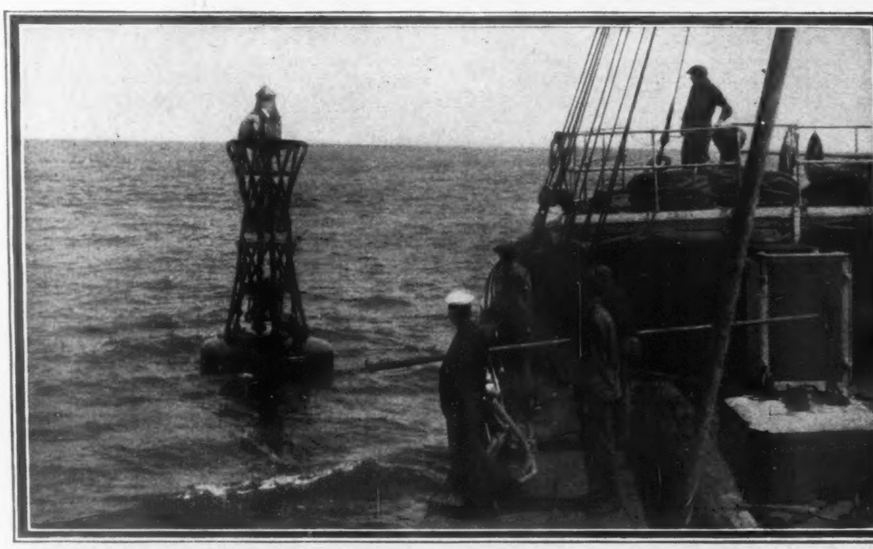
The work of erecting these lights has been greatly facilitated by the use of compressed air. Formerly to sink the steel supports deep into the sand, it was necessary to resort to pile drivers, which are cumbersome and somewhat expensive. Now the legs of the towers are "jetted down," as the operation is called in the service. A section of pipe of any desired length, with a perforated end, is the only tool required for the purpose. Water and compressed air are forced through this pipe, thus making holes into which the supports sink to a depth of 70 feet or more. At times, the pipes descend so rapidly that they must be held back to keep them from going too far. In this way, the post lights are set up at a great saving in time and labor.

There are four lighthouse depots in the United States and its possessions where construction and repair work is carried on and on which the relief boats and the lighthouse tenders are based. To these depots the lightships are brought about once a year to be overhauled and made fit for their lonely vigils. In order to do this work of reconditioning with all possible dispatch, compressed air is used wherever practicable.

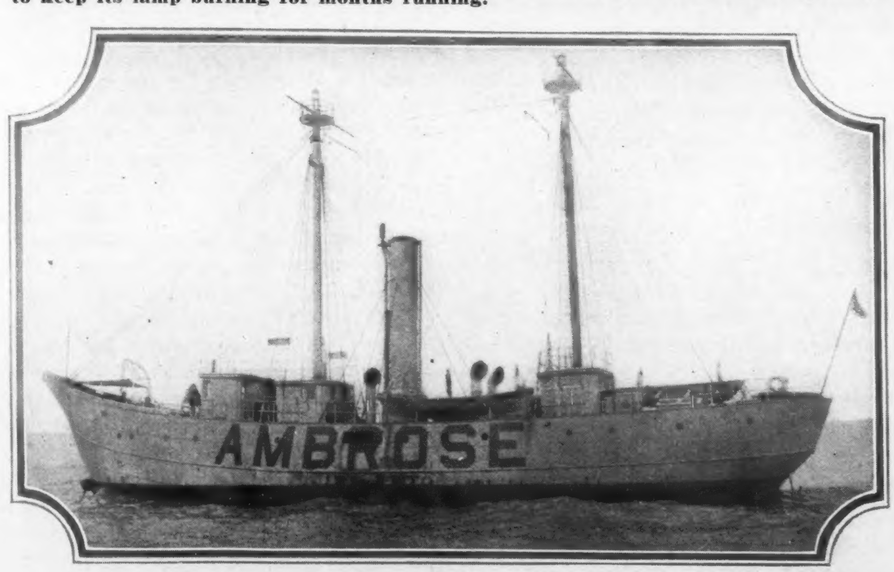
Among the many services performed by compressed air at the repair stations is that of calking vessels that must ride at anchor in more or less exposed positions along our coast, where they are not infrequently buffeted by storms. Lightships must, of necessity, be seaworthy, and to this end they must be promptly repaired and their seams made tight whenever pounding seas loosen rivets ever so little and permit water to find its way inboard. The calking is now done with air-operated tools that do the needful work quickly and well.



Lamp and air tanks used in lighthouses of minor order.



This beacon buoy, undergoing repair on station, blinks its warning flashes night and day to the navigator. It carries enough illuminating gas, under high pressure, to keep its lamp burning for months running.



Lightships are used to mark channels and navigational hazards at exposed points where the vessels are frequently battered by storm-swept seas.

Compressed Air Magazine

—Founded 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:

Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

EDITORIALS

OUR INDUSTRIES TOUCH NEW PEAK IN OUTPUT

THE United States, during the calendar year of 1925, reached the highest level in productivity ever attained in the industrial history of the country—such is the pronouncement made in the *Commerce Yearbook* just issued for 1925 by the United States Department of Commerce.

Why, many people will ask, was this peak reached in the year gone? The yearbook attributes the record to our steadily increasing industrial efficiency. To quote: "Recent careful calculations indicate that whereas the number of wage earners in our factories increased about 27 per cent. between 1914 and 1923, the output—in terms of quantitative volume and not in money value—increased by at least 60 per cent. In other words, production per wage earner employed advanced by approximately one-fourth. The principal immediate factors contributing are greater efficiency of the wage earners themselves, improved management, more scientific methods, waste elimination, and greater use of capital as an aid to human effort."

It goes without saying that a large share of this increasing production, this increasing efficiency, is directly attributable to the wide employment of machine tools and labor-lightening equipment of many sorts that enable the wage earner to do virtually as good work at the end of a shift as when going on his job fresh. A very considerable part of the mechanical facilities that make it possible to do this are tools or apparatus in which compressed air is the motive medium.

ELUSIVE ATLANTIS LOCATED IN AFRICA

ATLANTIS, a continent described by PLATO and other ancient writers—and generally believed to be mythical—has been located in the heart of the desert of Sahara by the German savant, Prof. PAUL BORCHARDT.

PLATO and his followers wrote that Atlantis lay in the Atlantic Ocean northwest of the coast of Africa; and, with its highly cultured inhabitants, disappeared beneath the surface of the sea during one of Nature's seismic convulsions. Since then, the imaginative have placed the original site of Atlantis in various parts of the Atlantic Ocean; but none of these speculative persons has heretofore seen fit to assign the position of the erstwhile island continent to a section of the sandy wastes of the Sahara. More than once we have been told that that desert formerly lay beneath the sea; and accepting this as likely, then it is not hard to believe that Atlantis or some kindred cultural center may have flourished where now are salt swamps not far from the coast in Tunis. This conclusion is supported by certain discoveries which have been made in the region and which have brought to light material evidences of a people that must once have enjoyed a high state of civilization.

In a recent dispatch to *The New York Times*, "Atlantis, so Professor BORCHARDT believes, sank to an unknown depth in 1250 B. C. during the earthquake which, according to DIODORUS, the Greek historian, swept this tectonic area extending from Teneriffe to Sicily, changing the geography of the entire disturbed sector."

Professor BORCHARDT bases his location of Atlantis upon data which he has obtained after years of intimate study of the territory and of the ancient and surviving languages of the region. As might be expected, the scientific world and educated people generally await with interest further disclosures which this geographer and traveler may make.

METALLURGY SPEEDS UP SUBMARINE CABLING

SUBMARINE cables for decades were the only nerves of communication that linked America with Europe and made it possible to dispatch a message and to receive an answer within an interval of minutes even though thousands of miles of trackless ocean intervened. The Atlantic cables have long served to promote cordial international relations, to develop foreign trade, and to remind the traveler that he was not beyond the reach of his friends or relatives despite the fact that seemingly limitless space lay between them.

In the earlier days, the Atlantic cables were slow means of communication when compared with the rapidity with which telegraphic messages could be flashed to and fro upon overland wires. The difference in speed of transmission was due to an electrical phenomenon, called "capacity," which obstructed the passage of the signaling impulses through the insulated, armored, subaqueous cables. The bugaboo of "capacity" has been battled with by electrical engineers in various ways and with different but increasing measures of success. Finally, the metallurgist has come to the rescue, and has latterly produced a combination of nickel and iron, known as permalloy, that now makes it possible to dispatch 2,500 words a minute where once upon a time it was practicable to transmit only 60 letters per minute.

Permalloy has added greatly to the speed of transmission over that possible with the best of cables otherwise equipped; and there are enthusiasts who believe this new nickle-iron alloy will ultimately permit a transmitting velocity of 5,000 letters a minute. On the face of it, it would seem that the subaqueous telegraphic cable has thus obtained a new lease of life and won for itself a much wider and more valuable field of usefulness. Here, again, we are indebted to the patient, painstaking labors of the man of the laboratory.

AUTOMATIC TRAIN CONTROL A SUCCESS

THE human equation has played for many years a big part in promoting accidents on railroads. Just once so often the experienced engineman, in a moment of inattention or in the belief that he can take a chance without really running a risk, fails to obey warning signals, and an accident of a more or less serious nature follows. Therefore, after nearly fifteen years of study, the Interstate Commerce Commission, four years ago, directed forty-five of our trunk lines to install automatic train-control apparatus on prescribed sections of their roads.

Many of the railroads objected strenuously to the order because a considerable number of them did not believe that the state of the art had emerged from the experimental stage; and all the lines concerned recognized that any equipment of the sort contemplated would necessarily entail heavy expenditures. Notwithstanding this attitude, the railroads set about obeying the order—each electing to test one or more of the train-control systems offered by American inventors. The fact that satisfactory systems were produced, capable of meeting very exacting operating demands, is splendid evidence of the genius of our people in mastering a mechanical problem that has bristled with many difficulties.

As is generally known by the public, the purpose of the automatic train control is to take the management of the locomotive out of the hands of an engineman when he refuses to heed the cautionary and the peremptory signals that successively warn him of danger ahead and call upon him to bring his train to a standstill. All types of approved forms of train-control equipment of the sort in question automatically apply the air brakes in time to prevent a train from entering a blocked section—blocked for any cause which might invite a catastrophe or an accident of lesser magnitude.

According to a recent report, the prescribed train-control installations are nearing 100 per cent. readiness on the forty-five roads mentioned—that is to say, out of 7,770 miles of track ordered to be so protected, train-control devices are in service or under construction on 7,503 miles. A second order, issued subse-

quently, has called for the placing of kindred safety apparatus on 7,500 miles of additional trackage; and 62 per cent. of this work is well advanced. Aside from installing the stationary or track equipment, it will be necessary for the lines affected to fit nearly 3,000 locomotives with responsive control mechanisms.

No one can rightly urge that automatic train-control systems will completely prevent accidents on railroads; but it can be claimed that these mechanical safeguards will inevitably reduce those mishaps that annually cost the railroads many millions of dollars and that they will lessen, to a measurable extent, the nervous and physical stresses under which the engineman labors.

AMERICAN COASTWISE TRADE ON THE INCREASE

DURING the first quarter of the present year, American ships engaged in intercoastal trade carried in excess of 2,314,000 tons of revenue-making cargo. This tide of traffic flowed between our Atlantic, Gulf, and Pacific ports by way of the Panama Canal. In the course of the period in question, the traffic showed a gain of substantially 220,000 tons over that moved between the seaboards during the same quarter in 1925.

While oil shipments predominated among the cargoes bound eastward from California, still there was noticeable a marked augmenting of cargoes of other sorts. This growth is significant of the industrial development of the contributing regions, and gratifying evidence of the greater part that the Isthmian Canal inevitably will play in the interchange of commodities bound to and from those sections of the country that can utilize to advantage transportation by water.

AIR AS AUXILIARY POWER ON SHIPBOARD

IN a paper on *Auxiliaries for Motor Vessels*, printed in *Mechanical Engineering*, attention is called to the use of compressed air on board ship. It is stated that air has been utilized to a certain extent as an auxiliary power medium, especially for operating the steering gear; and the turning of deck winches with compressed air has also been tried out. For these purposes, the use of low-pressure air, say from 25 to 30 pounds, is recommended. It is pointed out that the leakage losses are much less with air than with steam, and that but a single pipe is needed for transmission—the exhaust being negligible. It might be added that compressed air is always ready for service—that is, there is no warming-up delay, and little if any condensation.

The quantity of air needed for steering is surprisingly small: only 20 cubic feet of free air is required to keep a 5,000-ton vessel on her course. On a trip from England to America and back, in fine weather and with a skillful helmsman, from 35 to 40 cubic feet of air per minute was used, while in heavy weather, during eight hours of steady observation, it was found that the same work called for the application of from 90 to 95 cubic feet of air per minute.

THE MINING EDUCATOR, by John Roberts, D. I. C., M. I. Min. E., F. G. S., assisted by numerous specialists. A copiously illustrated work of two volumes and 1,770 pages. Published by Isaac Pitman & Sons, New York City. Price, $17.50 a set.

THE scope of this excellent compendium is such that it covers with sufficient completeness all essential knowledge dealing with mining that an ambitious person might wish to master in making himself efficient and able to increase his earning capacity in this field of industry. In a sense, the two volumes are designed to help the man who wants to help himself by study in his off hours. Therefore, the work includes arithmetic, algebra, and other departments of mathematics, and then carries the reader through surveying and the many other practical phases of mining—laying particular emphasis upon the mining of coal.

Inasmuch as so much of England's industrial greatness has developed from the working of her valuable deposits of coal, it is understandable why particular stress has been laid upon coal mining. The foreword frankly admits that British coal-mining methods have been wasteful and largely inefficient heretofore. To quote: "Our best and most easily mined seams of coal have been attacked for many years, and we are now faced with the prospect of mining deeper and thinner coals, some of which are not of superior quality. These conditions demand the employment of highly developed and efficient mechanical equipment, special consideration of the conditions of employment, increased skill on the part of the engineers, and the devoting of greater attention to the value of the mineral." Accordingly, the two volumes are designed to furnish in a handy form the information that will give aspiring mining men the technical training required to meet the changed conditions within the industry.

THE ROMANCE OF WORLD TRADE, by Alfred Pearce Dennis, LL.D., Vice Chairman United States Tariff Commission. An illustrated work of 493 pages, published by Henry Holt & Company, New York City. Price $4.00.

WORLD trade, as conceived by a large percentage of the populace, is nothing more thrilling than barter and sale carried on overseas. These people are quite unaware of the economic forces, the industrial urge, and the selling enterprise that enter into this vital department of national life. They are equally oblivious of the political significance of this exchange of commodities and transfer of capital. The subject is, indeed, a stirring one; and success in world trade can be won only in the face of keen competition and in the skillful playing of a game that calls for the continual matching of business wits.

Doctor Dennis writes out of the fullness of personal experience; and even when he presents his facts with photographic faithfulness he gives them the pleasing color of the imaginative artist. World trade, as he treats it, has its romantic side. We heartily commend this book to those unfamiliar with the subject and yet who are desirous of learning something about this matter which intimately concerns them sooner or later.

PRINTING INK, a History With a Treatise on Modern Methods of Manufacture and Use, by Frank B. Wiborg. An illustrated volume of 299 pages, published by Harper & Brothers, New York City. Price, $4.00.

PRINTING ink has played a conspicuous part in the civilizing of humankind by disseminating knowledge and by perpetuating information for living peoples and for their descendants following in their footsteps centuries later. Printing ink is no longer the simple pigment that it was in the early days of the art; and the evolution of printing ink is a romantic one that has called for the mastering of many difficulties. This has been especially true in recent times owing to the evolution of high-speed presses and to the general use of illustrations reproduced by photographic means.

Today, the printer must balance to a nicety the diversified demands of ink, paper, and plates, and produce the year round a product that will be satisfactory to the distributor and to the ultimate purchaser or reader. The general public knows little if anything about the seasonal handicaps under which the printer labors, and the ink used must be modified or changed so as to insure success when the air is humid or the temperature high.

Mr. Wiborg has written a very interesting book, and it should prove informative and valuable to a great many persons.

JORGENSEN, by Tristram Tupper. A novel published by J. B. Lippincott Company, Philadelphia. Price, $2.00.

THE story of an engineering undertaking in which man, with the mechanical forces now at his disposal, measures his wit and his comparatively puny strength with Nature in all her elemental austerity and seeming immovableness. In this particular case, the inspirational force in this battle with Nature is a gaunt, silent man who follows in the footsteps of the chief engineer and sees to it that things are done as ordered.

Self-absorbed as Jorgensen is in the great task in hand, still he unwittingly arouses the natures of two women—each the very opposite of the other in feeling, impulse, and mind. Each in her own way makes her appeal; and the imagination of the reader is gripped until the climax is reached that reveals which of these contrasting women wins the man whose every waking thought had so long been centered in his work. Tristram Tupper has written a vivid tale of engineering accomplishment and an equally alluring story of conflicting emotions.

How to Isolate Machine Vibrations is the title of a pamphlet issued by The Korfund Company, Inc., 11 Waverly Place, New York City. This pamphlet should be of interest to

engineers and industrial managers that have this problem before them and who are seeking ways to reduce the noise of plant operation.

Combating Corrosion in Industry. This book—issued by Chemical & Metallurgical Engineering, New York City—is a compilation of data and practical suggestions on corrosion problems, and is based on a survey of field reports and other sources of information having to do with this important topic.

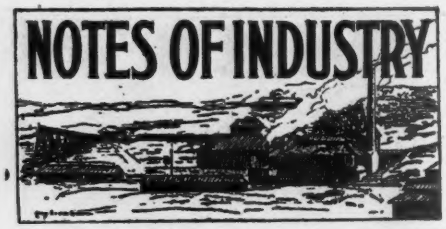
IMPORTANT LINK IN OUR CANAL SYSTEM

REFERRING to a map of the eastern portion of the United States, it may be noted that Chesapeake Bay and Delaware Bay approach each other very closely at their northernmost ends. The neck of land thus formed terminates in a peninsula, which extends southward for more than 150 miles and comprises the entire State of Delaware, a respectable portion of Maryland, and a valuable little strip of Virginia, with Cape Charles at its extremity.

For nearly a century, the Chesapeake and Delaware Canal—only 18 miles long, of limited capacity, and with several locks—has formed an important short cut, especially for freight, between Baltimore and Philadelphia. The very near future will see the completion of the arduous and costly conversion of this canal into what closely approaches a sea-level canal of greatly increased capacity. Work on the project, on which more than $10,000,000 has been spent, has been underway for five years. No brief summary can give an idea of what has been accomplished. In the main cut, the excavation reached a maximum depth of 76½ feet, and called for the removal of 7,000,000 cubic yards of material within a stretch of 4 miles. Altogether, a total of 16,000,000 cubic yards of material has been disposed of.

While spoken of as a sea-level canal it is not one, in fact. At the Delaware River end the mean rise and fall of the tide is 6 feet, and at the Chesapeake City end only 2½ feet; and there is a difference in time of about two hours in the occurrences of the tidal phases. In consequence, there are in all 13½ miles of locked-canal and 4.3 miles of tidal-canal navigation. Intended, for the present, to serve only as a barge canal, the plan is to turn it into a canal of sufficient depth to accommodate large ocean-going craft. In its ultimate form, it will be an important link in the national system of inland waterways extending from Beaufort, N. C., to New York and Boston.

Figures given out by the United States Bureau of Chemistry reveal that over 21,000 manufacturing plants in the country, turning out $7,000,000,000 worth of products annually, are continually confronted with the hazard of dust explosions. Records of 270 such catastrophes show that 444 lives were lost in 66 of them and that 780 persons were injured in 83 of them. The actual monetary loss resulting from 132 explosions of this nature amounted to $32,917,000, or more than $250,000 per explosion.



The United States Bureau of Standards is responsible for the statement that limestone is more extensively used as a building material than any other kind of natural stone.

During 1925, German air lines covered more than 2,158,360 miles and carried 48,000 passengers. In comparison with 1924, the amount of mail matter conveyed in this way increased fourfold, while freight transported increased a hundredfold. Aside from the tremendous strides made in commercial aviation in Germany, it is noteworthy that but two serious accidents were reported for the year.

By reason of forestation, the great gold-mining district of the Witwatersrand in the Union of South Africa—originally a treeless waste—is now able to supply about 40 per cent. of its timber requirements. Following suit, the decreasing quantity and the rising cost of good mine timber in Pennsylvania and in the Lake Superior district have led a number of metal-mine operators there to resort to reforestation to insure a source of future supply. Tree planting for mine use has also been started in the coal-mining regions of the Middle West.

Since 1916, the average yield of gasoline from crude oil in the United States has been doubled, according to a statement made by the National City Bank of New York. Because of the tremendous improvements made in this country within that period millions of barrels have been added to our supply of gasoline annually. Last year, the world production of crude petroleum amounted to 1,066,220,000 barrels. It is interesting to note that without the use of the "cracking" processes the 1925 gasoline output in the United States alone would have required more than the entire world production of crude.

A comparison of the foreign trade of the United States with that of other countries shows that our share in international commerce is increasing. The Department of Commerce has recently announced that American exports and imports in 1925 comprised 15.6 per cent. of the combined foreign trade of 55 countries which represent about nine-tenths of the world's commerce.

There has recently been submitted to the King of Belgium a plan proposing the construction of seven dams and associate hydro-electric plants on the Kongo River. The ultimate object of this great engineering project is to make the Kongo navigable from Matadi to Kinshasa.

The United States is the third largest consumer of India's raw jute, and purchases about two-thirds of the gunny cloth manufactured in that country.

Colombia now supplies about one-half of the world's platinum.

More paint and varnish are made and used in the United States than in any other part of the world, according to a recent survey of the American Chemical Society. Last year's output of paints, pigments, lacquers, and varnishes was valued at $440,565,000; and of this enormous production less than 4 per cent. was exported.

The Southern Pacific Railway Company of Mexico, which is building a line between Tepic, Nayarit, and Guadalajara, reports that the road will in all probability be opened to traffic in January of 1927. This new line will link important western trade centers in the United States with the entire Pacific coastal section of Mexico, including Guadalajara.

Of the water-power resources of the entire world, which have been estimated to be not less than 450,000,000 H. P., only about 30,000,000 H. P. is being utilized.

Work is soon to be undertaken on the Pykara hydro-electric project, the first of three important water-power developments in India. The Pykara is the largest river in the Nilgiris, and drops 400 feet in a series of falls. The plan is to impound about 4,000,000,000 cubic feet of water by building a dam across the river at a point above the falls. Generators capable of supplying 37,000 kilowatts are to be installed in the power house to be erected at the foot of the falls.

Comparative statistics are continually astonishing us. Who would think, offhand, that there are in the United States more automobiles than telephones? Yet the number of motor cars in use in the country today exceeds the total telephones in service by at least 1,500,000. In Pennsylvania, for instance, at the beginning of the present year, there were listed 1,317,053 automobiles and 1,123,851 telephones.

The Portland cement industry of the United States is now capable of turning out about 200,000,000 barrels annually, or one-fourth more than the record year's demand. There are 141 plants engaged in manufacturing this important building material, and these plants operate in 29 of our states—Pennsylvania, Indiana, California, Michigan, Missouri, New York, and Illinois being the largest producers.

The United States Navy now operates 48 radio-compass stations; and the service rendered by these stations is increasing annually. In 1925, a total of 83,900 ships was given bearings—an increase of 28 per cent. over the navigational aid given in this way during the preceding year.

IX

con-
about
red in

of the

used
part
ey of
year's
l var-
f this
. was

ny of
Tepic,
t the
traffic
l link
United
ion of

ent're
e not
0,000,-

n the
three
India.
ilgiris,
The
cubic
ss the
rators
are to
rected

aston-
, that
tomo-
f mo-
ds the
00,000.
inning
17,058

United
about
fourth
There
g this
plants
ia, In-
New
lucers.

tes 48
e ren-
nnual-
given
er the
ng the